Asante

IntraCore® 35516 Series

Layer 2/3/4 Gigabit Switches

User's Manual

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Layer 2/3/4 Gigabit Switches
User's Manual

Asanté Technologies, Inc.
2223 Old Oakland Road
San Jose, CA 95131
USA

SALES

800-662-9686 Home/Office Solutions
800-303-9121 Enterprise Solutions
408-435-8388

TECHNICAL SUPPORT

801-566-8991: Worldwide
801-566-3787: Fax
www.asante.com/support
support@asante.com

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Chapter 1: Introduction

Thank you for purchasing the Asanté IntraCore 35516 Series Gigabit switch. The IC35516 is from a family of multi-media and multi-protocol switches capable of supporting Layer 2 switching and Layer 3 and Layer 4 protocols. They are designed to offer industry-leading performance at a very competitive cost of ownership.

Important! This manual describes the hardware setup and configuration commands that are used by the IC35516. It is not intended to be a complete configuration guide for your specific network requirements.

Each IntraCore 35516 switch is a 16-port solution for Gigabit Ethernet switching using shared-memory architecture to achieve Gigabit switching on all ports. The highly integrated system includes MACs, Address Look-up, Content Addressable Memory (CAM), Switch Engine, Primary Buffer Memory, and programmable Quality of Service (QoS).

Two models in the IntraCore 35516 series cover different customer applications.

- The IC35516-T is a 16-port switch that has 12 10/100/1000BaseT ports and 4 dual-function Gigabit ports that support either 1000BaseT RJ-45 Gigabit ports or GBIC Gigabit ports.
- The IC35516-G is a 16-port switch that has 12 GBIC style Gigabit Ethernet ports and 4 dual-function Gigabit ports that support either 10/100/1000BaseT RJ-45 Gigabit ports or GBIC Gigabit ports.

The following types of GBIC modules are supported on the IC35516 switches:

- 1000SX multi-mode fiber for 500 m applications
- 1000LX single-mode fiber for 2 km applications
- 1000LH single-mode fiber for 20 km applications
- 1000LZ single-mode fiber for ultra distance (120 km) applications
- 1000BaseT copper Gigabit for low-cost 100 m applications

The system can operate as a stand-alone network or be used in combination with other IntraCore switches in the backbone.

1.1 Features

The IC35516 is a multi-media, multi-protocol (Ethernet, L2/L3/L4) switch. The following is a list of the switch's features:

- 16-port 10/100/1000 switch/router, integrating MACs, CAM, packet buffer memory, and switching engine
- Supports wire-speed L2 switching and L3 routing including L2 and IP multicast
- QoS provisioning on Layers 2/3/4 and 802.1p tag
- Flexible wire-speed packet classification
- Packet filtering
- Wire-speed MAC address learning on-chip
- Port-based VLAN support for 4K VLANs according to IEEE Std. 802.1Q
- SNMP, RMON, and SMON statistics counters supported on-chip

- 128 KB internal packet buffer
- Full duplex 1000 Mbps, full and half duplex 10/100 Mbps
- Support for Jumbo Frames (up to 32 KB in length)

1.2 Package Contents

The following items are included in the switch's package:

- Switch
- AC power cord
- Rackmount brackets with screws
- Rubber feet
- Setup Guide
- IntraCore 35516 CD-ROM

Contact your dealer immediately if any of these items is missing.

1.3 LEDs

The system's front panel LED display allows you to monitor the status of the switch. Refer to the following sections for LED information specific to the switch's model.

1.3.1 IC35516-T

The IC35516-T has one power LED indicator, one (optional) emergency power LED, and two LED indicators for each of the 16 ports. See the table below for a complete LED description.

LED	Color	Description
Power	Green	Power is on.
	Off	Power is off, or main power has failed.
Emergency Power	Green	Primary power has failed and optional power supply is powering the switch.
	Off	Optional power supply is in standby mode and primary power is working.
Link/Speed	Green	A valid 1000 Mbps link has been established on the port.
	Yellow	A valid 10/100 Mbps link has been established on the port.
	Off	No link has been established on the port.

Duplex/Activity	Green	A full-duplex link has been established on the port.
	Blinking Green	Activity has been detected in full-duplex mode.
	Yellow	A half-duplex link has been established on the port.
	Blinking Yellow	Activity has been detected in half-duplex mode.
	Off	No link has been established on the port.

1.3.2 IC35516-G

The IntraCore 35516-G has one power LED, one (optional) emergency power LED, two LED indicators for 10/100/1000BaseT status, and one LED for GBIC status. See the table below for a complete LED description.

LED	Color	Description
Power	Green Off	Power is on. Power is off, or main power supply has failed.
Emergency Power	Green Off	Primary power has failed and optional power supply is powering the switch. Optional power supply is in standby mode and primary power is working.
BaseT 10/100/1000 Link/Speed	Green Yellow Off	A valid 1000 Mbps link has been established on the port. A valid 10 or 100 Mbps link has been established on the port. No link has been established on the port.
BaseT 10/100/1000 Duplex/Activity	Green Blinking Yellow Blinking Yellow Off	A full-duplex link has been established on the port. Activity is detected in full-duplex mode. A half-duplex link has been established on the port. Activity is detected in half-duplex mode. No link has been established on the port.
GBIC Link	Green Off	A valid 1000 Mbps link has been established on the port. No link has been established on the port.

1.4 Front and Back Panel Descriptions

Refer to the following sections for detailed descriptions of the front and back panels of the IC35516 Series switches.

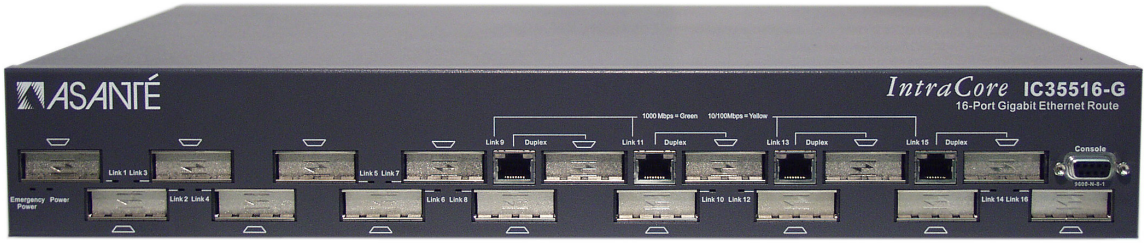
1.4.1 IC35516-T

The front panel of the IC35516-T contains the following: power and port LEDs, 12 10/100/1000BaseT ports, 4 dual-function Gigabit ports that support either 1000BaseT or GBIC-style Gigabit Ethernet ports, and a console port.

The back panel, not shown, contains a 12 VDC jack for emergency power (optional), the primary power bay cover plate, the primary power outlet, and the on/off switch.

1.4.2 IC35516-G

The front panel of the IC35516-G contains the following: power and port LEDs, 12 GBIC ports, 4 dual-function Gigabit ports that support either 1000BaseT or GBIC-style Gigabit Ethernet ports, and a console port.



The back panel, shown below, contains a 12 VDC jack for emergency power (optional), the primary power bay cover plate, the on/off switch, and the primary power outlet.

1.5 Management and Configuration

The switch is managed using Command Line Interface (CLI) in order to access several different command modes. Entering a question mark (?) at each command mode's prompt provides a list of commands.

1.5.1 Console Interface

Support for local, out-of-band management is delivered through a terminal or modem attached to the EIA/TIA-232 interface. Users can access the switch by connecting a PC or terminal to the console port of the switch, via a serial cable. The default password set on the console line is **Asante** (it is case-sensitive). The default IP address is **192.168.0.1/24**. The default settings for the terminal emulation program are as follows:

9600-8-N-1

Remote in-band management is available through Simple Network Management Protocol (SNMP) and Telnet client. When connecting via a Telnet session (line vty0), the default password is also **Asante** (case-sensitive).

See Chapter 2 for more information on connecting to the switch.

Chapter 2: Hardware Installation and Setup

The following guidelines will help you easily install the switch, ensuring that it has the proper power supply and environment.

2.1 Installation Overview

Follow these steps to install the IntraCore switch:

1. Open the box and check the contents. See *Chapter 1.2 Package Contents* for a complete list of the items included with the IntraCore switch.
2. Install the switch in an equipment or wall rack, or prepare it for desktop placement.
3. Connect the power cord to the switch and to an appropriate power source.
4. Connect network devices to the switch.

See the sections below for more detailed installation instructions.

2.1.1 Safety Overview

The following information provides safety guidelines to ensure your safety and to protect the switch from damage.

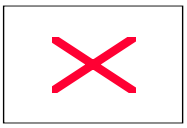
Note: This information is intended as a guideline, and may not include every possible hazard to which you may be exposed. Use caution when installing this switch.

- Only trained and qualified personnel should be allowed to install or replace this equipment
- Always use caution when lifting heavy equipment
- Keep the switch clean
- Keep tools and components off the floor and away from foot traffic
- Avoid wearing rings or chains (or other jewelry) that could get caught in the switch. Metal objects can heat up and cause serious injury to persons and damage to the equipment. Avoid wearing loose clothing (such as ties or loose sleeves) when working around the switch

When working with electricity, follow these guidelines:

- Disconnect all external cables before installing or removing the cover
- Do not work alone when working with electricity
- Always check that the cord has been disconnected from the outlet before performing hardware configuration
- Do not tamper with the equipment. Doing so could void the warranty
- Examine the work area for potential hazards (such as wet floors or ungrounded cables)

2.1.2 Recommended Installation Tools



You will need the following tools and equipment (not included) to install the switch into an equipment rack:

- Flat head screwdriver
- Phillips head screwdriver
- Antistatic mat or foam

2.1.3 Power Requirements

The electrical outlet should be located near the switch and be easily accessible. It must also be properly grounded.

Make sure the power source adheres to the following guidelines:

- Power: Auto Switching 90-260 VAC
- Frequency range: 50/60 Hz

2.1.4 Environmental Requirements

The switch must be installed in a clean, dry, dust-free area with adequate air circulation to maintain the following environmental limits:

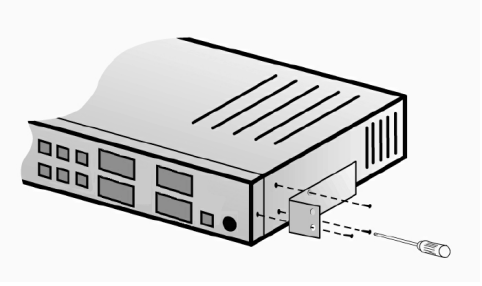
- Operating Temperature: 0° to 40°C (32° to 104°F)
- Relative Humidity: 10% to 90% non-condensing

Avoid direct sunlight, heat sources, or areas with high levels of electromagnetic interference. Failure to observe these limits may cause damage to the switch and void the warranty.

2.1.5 Cooling and Airflow

The IC35516 switches use internal fans for air-cooling. Do not restrict airflow by covering or obstructing air vents on the sides of the switch.

2.2 Installation into an Equipment Rack



Important! Before continuing, disconnect all cables from the switch.

To mount the switch onto an equipment rack:

1. Place the switch on a flat, stable surface.
2. Locate a rack-mounting bracket (supplied) and place it over the mounting holes on one side of the switch.
3. Use the screws (supplied) to secure the bracket (with a Phillips screwdriver).
4. Repeat the two previous steps on the other side of the switch.
5. Place the switch in the equipment rack.

6. Secure the switch by securing its mounting brackets onto the equipment rack with the appropriate screws (supplied).

Important! Make sure the switch is supported until all the mounting screws for each bracket are secured to the equipment rack. Failure to do so could cause the switch to fall, which may result in personal injury or damage to the switch.

2.2.1 Equipment Rack Guidelines

Use the following guidelines to ensure that the switch will fit safely within the equipment rack:

- Size: IC35516-T: 17.1 x 10.1 x 1.6 inches (434 x 257 x 41 mm)
  IC35516-G: 17.5 x 14.0 x 2.6 inches (445 x 356 x 66 mm)

- Ventilation: Ensure that the rack is installed in a room in which the temperature remains below 40° C (104° F). Be sure that no obstructions, such as other equipment or cables, block airflow to or from the vents of the switch

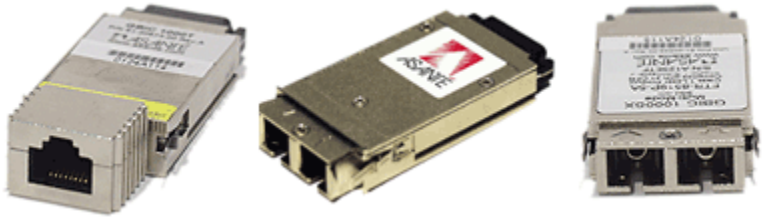
- Clearance: In addition to providing clearance for ventilation, ensure that adequate clearance for servicing the switch from the front exists

2.3 Gigabit Interface Converters

The GBIC Interface is the industry standard for Gigabit Ethernet Interfaces. Some of the benefits of GBIC include reducing the components needed in a “spares” inventory, being able to choose from a wide variety of manufacturers with cross-vendor compatibility, and having competitive prices.

Instructions for installing, removing, and maintaining GBIC modules are provided in following sections.

Important! The 35516-G has 12 GBIC ports that are paired— port numbers 1/2, 3/4, 5/6, 7/8, 10/12, and 14/16. **DO NOT** use more than one copper GBIC module per pair (maximum 8 modules).



Model	Part Number	Standard	Media
GBIC 1000SX	99-00549-01	1000BaseSX	Multi-mode fiber
GBIC 1000LX	99-00550-01	1000BaseLX	Single-mode fiber
GBIC 1000T	99-00673-01	1000BaseT	Category 5 UTP (or better) copper
GBIC 1000TP	99-00647-07	1000BaseT	Category 5 UTP (or better) copper

Table 2-1 GBIC Modules by Asanté

2.3.1 Installing a GBIC

GBICs are hot-swappable. This means that they can be inserted and removed while the switch is powered on. However, please allow 40–60 seconds for the switch to recognize the module when it has been installed while the switch is on.

1. Wearing an ESD (electro-static discharge) wrist strap, remove the GBIC module from its protective packaging.
2. Verify that the GBIC is the correct type for the network (see the table above).
3. Grip the sides of the GBIC with the thumb and forefinger, and then insert the GBIC into the slot on the face of the switch.
4. Slide the GBIC into the slot until it clicks into place.
5. Fiber GBIC modules: Remove the rubber plugs from the end of the GBIC module. Save them for future use.
6. Attach the appropriate cable.

Note: After installing a GBIC 1000T module, the link LED may light even before a valid cable has been connected. This is a normal condition for most 1000BaseT GBIC modules.

Note: Auto-negotiation must be disabled on a port in which a copper GBIC module is installed. Copper GBICs themselves control auto-negotiation.

2.3.2 Removing a GBIC

Caution: GBIC 1000T modules run hot under normal operating conditions. When it has been removed from the system, place it on a heat-resistant surface and allow the module to cool before handling.

Note: Unnecessary removals/insertions of a GBIC module will lead to premature failure of the GBIC connector. The rated duty cycle for a GBIC module is 100–500 removals/insertions.

Follow the steps below to remove a GBIC interface from a Gigabit Ethernet module:

1. Disconnect the cable from the GBIC module.
2. Release the GBIC from the slot by simultaneously squeezing the locking tabs on both sides of the GBIC.
3. Slide the GBIC out of the slot.
4. Fiber GBIC modules: Install the rubber plugs in the GBIC optical bores, and place the GBIC in protective packaging.

2.3.3 GBIC Care and Handling

Follow these GBIC maintenance guidelines:

- GBICs are static-sensitive. To prevent ESD damage, follow normal board and component handling procedures. Wear an ESD wrist strap
- Fiber GBIC modules are very sensitive to dust and contaminants. When they are not connected to a fiber-optic cable, install the rubber plugs in the optical bores
- The ferrules of the optical connectors may pick up debris that can obstruct the optical bore. Use an alcohol swab or equivalent to clean the ferrules of the optical connector

2.4 Installing the Optional Emergency Power Supply

To ensure increased reliability for mission-critical applications, the IC35516 can be equipped with a 12 VDC emergency backup power supply (the IC35-EPS12, sold separately). When installed, the emergency power supply is in standby mode. Should the primary unit fail, the DC backup automatically switches on and the LED on the front panel lights. In addition, an SNMP fault notice is sent.

To verify the primary power status, use the `Router#` **`show system`** command. Under System Information, you will see the power unit status.

```
System Information
------------------
  System up since: 10:34:43 Fri Mar 19 2004
  PROM Image Version/Date:    1.01A/Jan 20 2004 20:24:10
  DRAM Size:            64.0MB      Flash Size:         8.0MB
  Config NVRAM Size:     128KB      Console Baud Rate:  9600 bps
  Serial No. :
  Power Unit Status = OK
```

Should the IC35-EPS12 become active due to a fault with the primary power, the unit should be swapped out at the earliest convenience and sent for repair. The IC35-EPS12 is designed to be a temporary replacement when the primary power fails, not a permanent replacement.

To install the optional power supply, simply attach the 12 VDC connector of the power supply to the jack located in the center of the rear panel of the switch. Connect the power cord to the power supply and plug the power cord into an outlet.

Important! The optional power supply becomes **HOT** under normal operating conditions. To avoid damage or injury, set the power supply on a heat-resistant surface and **USE CAUTION** when handling the unit.

2.5 Connecting Power

Important: Carefully review the power requirements (Chapter 2.1.3) before connecting power to the switch.

Use the following procedure to connect power to the switch:

1. Plug one end of the supplied power cord into the power connector on the back of the switch.
2. Plug the other end into a grounded AC outlet.
3. Turn on the switch's power. The power LED will begin its initialization process.

The front panel LEDs blink and the power LED illuminates when it has initialized. The switch is ready for connection to the network.

Important: If the power does not come on, check the next section to ensure that the correct cabling is used.

2.6 Connecting to the Network

The switch may be connected to an Ethernet network with the switch powered on or off. Use the following procedure to make the network connections:

1. Connect the network devices to the switch, following the cable guidelines outlined below.

2. After the switch is connected to the network, it can be configured for management capabilities (see the following chapters for information on configuration).

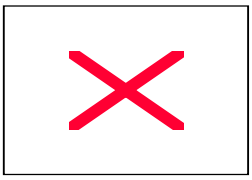
2.6.1 10/100/1000BaseT Ports Cabling Procedures

The 10/100/1000 ports on the switch allow for the connection of 10BaseT, 100BaseTX, or 1000BaseT network devices. The ports are compatible with IEEE 802.3 and 802.3u standards.

Important: The switch must be located within 100 meters of its attached 10BaseT or 100BaseTX devices.

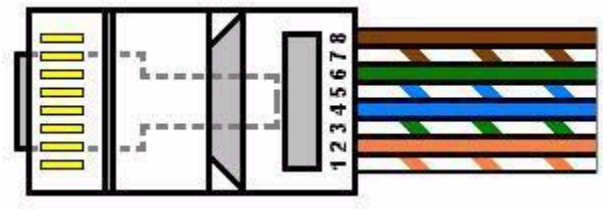
Use the following guidelines to determine the cabling requirements for the network devices:

- Connecting to Network Station: Category 5 UTP (Unshielded Twisted-Pair) straight-through cable (100 m maximum) with RJ-45 connectors
- Connecting to Repeater/Hub/Switch's Uplink port: Category 5, UTP straight-through cable (100 m maximum) with RJ-45 connectors



Note: These switches have no specific uplink ports. All 10/100/1000 ports on these switches are auto-sensing MDI/MDI-X. This advanced feature means that when the ports are operating at 10/100Mbps, they will automatically determine whether the device at the other end of the link is a hub, switch, or workstation, and adjust its signals accordingly. No crossover cables are required.

Although 10/100BaseT requires only pins 1, 2, 3, and 6, Asanté strongly recommends cables with all 8 wires connected as shown in Table 2-2 below.



1000BaseT requires that all four pairs (8 wires) be connected correctly, using Category 5 or better Unshielded Twisted Pair (UTP) cable (to a distance of 100 meters). Table 2-2 shows the correct pairing of all eight wires.

Pin Number	Pair Number & Wire Colors
1	2 White / Orange
2	2 Orange / White
3	3 White / Green
4	1 Blue / White
5	1 White / Blue
6	3 Green / White
7	4 White / Brown
8	4 Brown / White

Table 2-2 Pin Numbers and Wire Colors

2.6.2 Gigabit Ethernet Ports Cabling Procedures

Cabling requirements for the optional hardware modules depend on the type of module installed. Use the following guidelines to determine the particular cabling requirements of the module(s):

- 1000BaseSX GBIC: Cables with SC-type fiber connectors; 62.5µ multi-mode fiber (MMF) media up to 275 m (902'), or 50µ MMF media up to 550 m (1805')
- 1000BaseLX GBIC: Cables with SC-type fiber connectors; 10µ single-mode fiber media up to 5 km (16,405')
- 1000BaseLH GBIC: Cables with SC-type fiber connectors; 10µ single-mode fiber media up to 20 km (65,617')
- 1000BaseLX Long Haul GBIC: Cables with SC-type fiber connectors; 10µ single-mode fiber media up to 100 km (328,100')
- 1000BaseLZ GBIC: Cables with SC-type fiber connectors; 10µ single-mode fiber media up to 120 km (393,701')
- 1000BaseT: Category 5 or better Unshielded Twisted Pair (UTP) cable up to 100 m (328.1')

When attaching a workstation to the switch, a standard straight-through CAT5 cable may be used, even when the workstation is attached via a patch panel. No crossover cable is needed with the MDX/MDI ports. It is recommended that the switch be kept off the network until proper IP settings have been set.

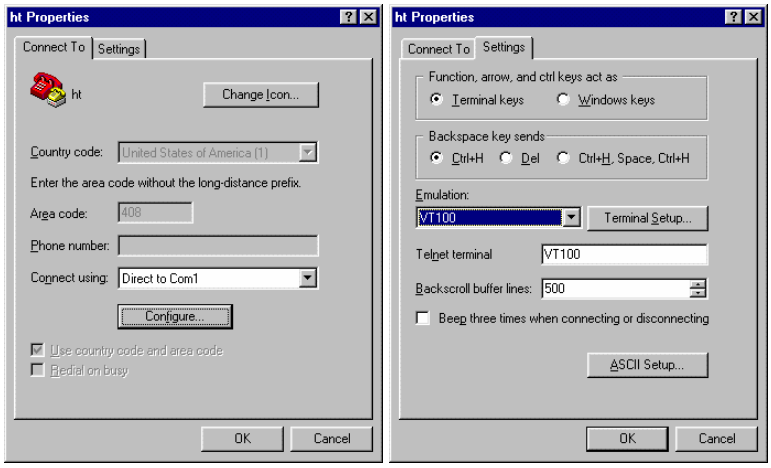
2.7 Setup

In order to configure the switch, connect to it through a console (out-of-band management), running a terminal emulation program, such as HyperTerminal.

2.7.1 Connecting to a Console

To connect the switch to a console or computer, set up the system in the following manner:

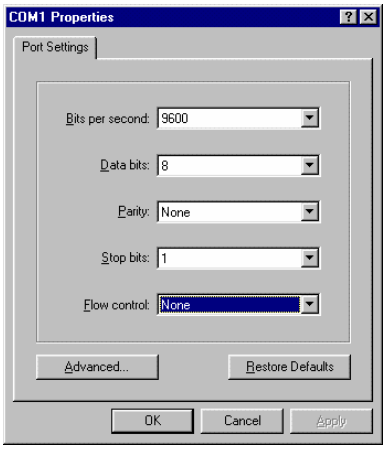
1. Plug power cord into the back of the switch.
2. Attach a straight-through serial cable between the RS232 console port and a COM port on the PC.
3. Set up a HyperTerminal (or equivalent terminal program) in the following manner:
    a. Open the HyperTerminal program, and from its file menu, right-click on **Properties.**
    b. Under the **Connect To** tab, choose the appropriate COM port (such as COM1 or COM2).



c. Under the **Settings** tab, choose VT100 for Emulation mode.

d. Select Terminal keys for Function, Arrow, and Ctrl keys. Be sure the setting is for Terminal keys, NOT Windows keys.

e. Back under the **Connect To** tab, press the **Configuration** button.



f. Set the data rate to 9600 Baud.

g. Set data format to 8 data bits, 1 stop bit and no parity.

h. Set flow control to NONE.

Now that terminal is set up correctly, power on the switch. The boot sequence will display in the terminal.

After connecting to the console, a prompt like the following will appear:

```
User Access Verification
Password:
```

By default, the initial password for access via console and telnet is **Asante** (case-sensitive). See the following section for setting new passwords on the terminal lines.

2.8 Setting Passwords

The switch ships with a default of no enable password, which allows anyone on the network access to various privilege levels. To prevent unauthorized changes to the switch's configuration, you should set an enable password for access to switch management. Follow the example below to assign a privileged password.

```
Router> enable
Password: <no password by default; press Enter>
Router# configure terminal
Router(config)# enable password ?
  0     Specifies an UNENCRYPTED password will follow
  7     Specifies a HIDDEN password will follow
  LINE  The UNENCRYPTED (cleartext) 'enable' password
Router(config)# enable password 0 <password>
Router(config)# exit
Router# write [memory  file]
```

A separate password should be set for the primary terminal line (console) and the virtual terminal lines (telnet). The default password **Asante** is assigned only to the virtual terminal line Vty0. Up to three other virtual terminal lines may be created, and they each will require a separate password.

Note: It is recommended that you change the default telnet password to prevent unauthorized access to the switch.

```
Router(config)# line ?
  console  Primary terminal line
  vty      Virtual terminal
Router(config)# line console ?
  <0-0>  Line number
Router(config)# line console 0
Router(config-line)# ?
  end           End current mode and change to enable mode
  exec-timeout  Set timeout value
  exit          Exit current mode and down to previous mode
  help          Description of the interactive help system
  no            Negate a command or set its defaults
  password      Set a password
  quit          Exit current mode and down to previous mode
Router(config-line)# password ?
  LINE  The UNENCRYPTED (cleartext) line password
  0     Specifies an UNENCRYPTED line password will follow
  7     Specifies a HIDDEN line password will follow
Router(config-line)# password Asante
Router(config-line)# end
Router# write ?
  file      Write to configuration file
  memory    Write configuration to the file (same as write file)
  terminal  Write to terminal
Router# write file
Writing current-config to startup-config, Please wait...
Configuration saved to startup-config file
Router#
```

The password can be set at unencrypted (level 0) or encrypted (level 7).

```
Router(config-line)# password ?
  LINE  The UNENCRYPTED (cleartext) line password
  0     Specifies an UNENCRYPTED line password will follow
```

```
  7     Specifies a HIDDEN line password will follow
```

2.9 Login Security

Two methods are available on the IntraCore 35516 to configure an authentication query process for better login security: the **username** command or the **password** and **login** commands.

2.9.1 The username Command

To establish a username-based authentication system, use the **username** command in global configuration mode. This method is more effective because authentication is determined on a user basis. The configuration is done for each line.

```
Router(config)# line console 0
       Or
Router(config)# line vty vty-number

Router(config-line)# login user
Router# username name password password
```

The name argument can be a host name, server name, user ID, or command name. It is restricted to only one word. Blank spaces and quotation marks are not allowed.

Optionally, an encrypted password can be used, preceded by a single-digit number that defines what type of encryption is used. Currently defined encryption types are 0 (which means that the text immediately following is not encrypted) and 7 (which means that the text is encrypted using an encryption algorithm).

2.9.2 The password and login Commands

Using the **password** and **login** commands is less effective because the password is configured for the port, not for the user. Therefore, any user who knows the password can authenticate successfully.

This method enables user name and password checking at login time. Authentication is based on the user.

Note that login user is **NOT** set by default. The “root” user is the only default user; the password is the same as line password.

2.10 Configuring an IP Address

The switch ships with the default IP address **192.168.0.1/24**. Connect via the serial port in order to assign the switch an IP address on your network.

The physical ports (or switchports) of the IC35516 are L2 ports, and cannot have an IP address assigned to them. By default, each switchport belongs to VLAN 1, a virtual interface (veth1) that may be assigned a primary, as well as any number of secondary, IP addresses. Use the following instructions to configure an IP address to the switch. The network administrator may later assign primary IP addresses to any other VLAN created.

Follow the steps below to change the switch’s IP address.

1. Connect to the console and press **Enter** at the Password prompt, as described above.

2. The screen will display the user mode prompt, `Router>`.

3. Type **enable**. The new prompt is `Router#`.

4. Type **configure terminal**. The new prompt is `Router(config)#`.

5. The default IP address is assigned to the veth1 interface. Type **interface veth1**. The new prompt is `Router(config-if-veth1)#`. Type **ip address** and the new address. Your screen will look like this example:

```
Router> enable
Router# configure terminal
Router(config)# interface veth1
Router(config-if-veth1)# ip address 192.168.123.254 255.255.255.0
Router(config-if-veth1)# end
Router# show interface veth1
Veth1 is up, line protocol is up
  Hardware is virtual interface VLAN 1, address is 00:00:94:D2:56:FA
  Encapsulation ARPA, Flags: <UP,BROADCAST,RUNNING,MULTICAST>
  inet 192.168.123.254/24 broadcast 192.168.123.255
  ARP Type: ARPA, ARP Timeout: 14400 seconds
Router# write file
Writing current-config to startup-config. Please wait.
Configuration saved to startup-config file
```

It is also acceptable to enter the subnet mask by typing `ip address 192.168.123.254/24`. Use the **show interface veth1** command from privileged mode to see the new IP address. The new IP address automatically writes over the default IP address.

See Chapter 5 for more information on assigning IP addresses to interfaces.

2.10.1 Setting a Default IP Gateway Address

To define the default IP gateway for the switch, insert a static route:

```
Router(config)# ip route 0.0.0.0 255.255.255.255  <gateway IP> <mask>
```

2.11 Restoring Factory Defaults

If you ever need to restore the switch to its factory default settings, follow the commands shown in the following screen.

```
Router> enable
Router# reload factory-default
```

The switch is now ready for configuration. Refer to the following chapters for management and configuration information.

2.12 System Boot Parameters

The IC35516 has two boot banks to store its runtime code. You can select which bank will be used for the next boot with the following command:

```
Router(config)# boot system flash {bank1|bank2}
```

Chapter 3: Understanding the Command Line Interface (CLI)

The switch utilizes Command Line Interface (CLI) to provide access to several different command modes. Each command mode provides a group of related commands.

After logging into the system, you are automatically in the *user top (user EXEC) mode*. From the user top mode you can enter into the *privileged top (privileged EXEC) mode*. From the privileged EXEC level, you can access the global configuration mode and specific configuration modes: interface, router, and route-map configuration. Entering a question mark (?) at the system prompt allows you to obtain a list of commands available for each command mode. Almost every router configuration command also has a **no** form. You can use the **no** form to disable a feature or function. For example, **ARP** is enabled by default. Specify the command **no arp** to disable the ARP table (see section 3.7).

Document Conventions

Command descriptions use the following conventions:

- Vertical bars (|) separate alternative, mutually exclusive, elements
- Square brackets ([ ]) indicate optional elements
- Braces ({ }) indicate a required choice
- Braces within square brackets ([{ }]) indicate a required choice within an optional element
- **Boldface** indicates commands and keywords that are entered literally as shown
- *Italics* indicate arguments for which you supply values

Access Each Command Mode

The following sections describe how to access each of the CLI command modes:

- User Top Mode: Router>
    - Privileged Top Mode: Router#
        - Global Configuration Mode: Router(config)#
            - Interface Configuration Mode: Router(config-if-IFNAME)#
            - Router Configuration Mode: Router(config-RTNAME-router)#
            - Route-Map Configuration Mode: Router(config-route-map)#

3.1 User Top (User EXEC) Mode

After you log in to the router, you are automatically in user top (user EXEC) command mode. The user-level prompt consists of the host name followed by the angle bracket (>):

```
Router>
```

The default host name is *Router* unless it has been changed during initial configuration, using the **setup** command.

The user top commands available at the user level are a subset of those available at the privileged level. In general, the user top commands allow you to connect to remote devices, change terminal settings on a temporary basis, perform basic tests, and show system information.

To list the commands available in user top mode, enter a question mark (?). Use a space and a question mark (?) after entering a command to see all the options for that particular command.

Command	Purpose
?	Lists the user EXEC commands.
show ?	Lists all the options available for the given command.

User top commands:

```
Router> ?
 enable   Turn on privileged mode command
 exit     Exit current mode and down to previous mode
 help     Description of the interactive help system
 ping     Send echo messages
 quit     Exit current mode and down to previous mode
 show     Show running system information
 tracert  Trace route to destination
 cls      Clear screen
```

You may also enter a question mark after a letter or string of letters to view all the commands that start with that letter (with no space between the letter and the question mark). See section 3.8.2.

3.2 Privileged Top (Privileged EXEC) Mode

Because many of the privileged commands set the system configuration parameters, privileged access can be password protected to prevent unauthorized use. The privileged command set includes those commands contained in user EXEC mode, as well as the **configure** command through which you can access the remaining command modes. Privileged EXEC mode also includes high-level testing commands, such as **debug**.

The following example shows how to access privileged EXEC mode. Note that the prompt changes from *Router>* to *Router#*:

```
Router> enable
Password: <your password>
Router#
```

Command	Purpose
Router> **enable** [*password*]	Enters the privileged EXEC mode.
Router**# ?**	Lists privileged EXEC commands.

If you have set a password, the system prompts for it before allowing access to privileged EXEC mode. If an enable password has not been set, the enable mode can be accessed only through the console. You can enter the **enable password** global configuration command to set the password that restricts access to privileged mode.

To return to user EXEC mode, use the **disable** command.

In general, the top (privileged) commands allow you to change terminal settings on a temporary basis, perform basic tests, and list system information. To list the commands available in top mode, enter a question mark (?) at the

prompt, as shown in the following example. Enter a question mark (?) after a command to see all the options for that command.

```
Router> enable
Router# ?
  clear      Reset functions
  clock      Manage the system clock
  configure  Enter configuration mode
  copy       Copy from one file to another
  debug      Debugging functions
  disable    Turn off privileged mode command
  erase      Erase a filesystem
  exit       Exit current mode and down to previous mode
  help       Description of the interactive help system
  no         Negate a command or set its defaults
  ping       Send echo messages
  quit       Exit current mode and down to previous mode
  reload     Halt and perform a cold restart
  show       Show running system information
  tracert    Trace route to destination
  write      Write running configuration to memory, network, or terminal
  cls        Clear screen
```

Important! You **MUST** save any changes you make in running configuration to the startup configuration file if you want those changes to remain after a system reload. From the privileged level, configurations can be saved using the **write** command, or by using the **copy running-config startup-config** command.

From the privileged level, you can access global configuration mode, as described in the following section.

3.3 Global Configuration Mode

Global configuration commands apply to features that affect the system as a whole, rather than just one protocol or interface. Commands to enable a particular routing function are also global configuration commands. To enter the global configuration mode, use the **configure terminal** command.

The following example shows how to access and exit global configuration mode and list global configuration commands.

Command	**Purpose**
Router**# configure terminal**	From privileged EXEC mode, enters global configuration mode.
Router(config)**# ?**	Lists the global configuration commands.

To exit global configuration command mode and return to privileged EXEC mode, use one of the following commands:

Command	**Purpose**
exit **end**	Exits global configuration mode and returns to privileged

Ctrl-Z	EXEC mode.

To list the commands available in global configuration mode, enter a question mark (?) at the prompt, as shown in the following example. Enter a question mark (?) after a command to see all the options for that command.

```
Router# configure terminal
Router(config)# ?
  access-list          Add an access list entry
  adp                  Global ADP configuration subcommands
  arp                  Set static arp entry
  banner               Define a login banner
  bgp                  BGP information
  boot                 Modify system boot parameters
  define               Create a definition
  dot1x                IEEE 802.1x configuration
  duplicate-ip         Duplicate IP Address detection Global Commands
  enable               Modify enable password parameters
  end                  End current mode and change to enable mode
  exit                 Exit current mode and down to previous mode
  help                 Description of the interactive help system
  hostname             Set system's network name
  interface            Select an interface to configure
  ip                   Global IP configuration subcommands
  lacp                 Configure LACP
  line                 Configure a terminal line
  logging              Message Logging global configuration commands
  mac                  Add a MAC access list entry
  mac-address-table    MAC Address Table global configuration command
  no                   Negate a command or set its defaults
  priority-list        Priority List global configuration commands
  priority-precedence  Set priority source precedence
  queue-list           Queue List global configuration commands
  quit                 Exit current mode and down to previous mode
  route-map            Create route-map or enter route-map command mode
  router               Enable a routing process
  service              Modify use of network based services
  set                  set operations
  show                 Show running system information
  snmp-server          Modify SNMP parameters
  spanning-tree        Enable Spanning Tree Protocol
  tacacs-server        Modify TACACS+ query parameters
  tos-list             Tos List global configuration commands
  username             To establish a username-based authentication system
  vlan                 VLAN global configuration command
  write                Write running configuration to memory, network, or terminal
```

From global configuration mode, you can access three additional configuration modes: The **interface**, **router**, and **route-map** commands are used to access their respective configuration modes.

3.3.1 Interface Configuration Mode

Many features are enabled on a per-interface basis. Interface configuration commands modify the operation of an interface such as an Ethernet or serial port. Interface configuration commands always follow an **interface** global

configuration command, which defines the interface type as ethernet or virtual. The virtual interfaces are bound to VLANs and can be assigned IP addresses.

In the following example, Ethernet interface eth1 is about to be configured. The new prompt, `Router(config-if-eth1)#`, indicates the interface configuration mode. In this example, the user asks for help by requesting a list of commands.

```
Router(config)# interface eth1
Router(config-if-eth1)# ?
  adp                 ADP interface subcommands
  custom-queue-list   Assign a custom queue list to an interface
  description         Interface specific description
  dot1x               IEEE 802.1x configuration
  duplex              Configure duplex operation
  end                 End current mode and change to enable mode
  exit                Exit current mode and down to previous mode
  fair-queue          Fair-queue interface configuration commands
  flow-control        IEEE 802.3X Flow Control Configuration commands
  help                Description of the interactive help system
  ip                  Interface Internet Protocol config commands
  lacp                Configure LACP
  mac                 control access to an interface
  mtu                 Set the interface Maximum Transmission Unit (MTU)
  negotiation         Select Autonegotiation mode
  no                  Negate a command or set its defaults
  priority-group      Assign a priority queue list to an interface
  quit                Exit current mode and down to previous mode
  show                Show running system information
  shutdown            Shutdown the selected interface
  spanning-tree       Spanning Tree Protocol interface command
  speed               Configure speed operation
  switchport          Port operating in L2 mode
  tos-group           Assign a tos list to an interface
  traffic-shape       Generic traffic shape QoS interface configuration commands.
  write               Write running configuration to memory, network, or terminal
```

To exit interface configuration mode and return to global configuration mode, enter the **exit** command. To exit configuration mode and return to top mode, use the **end** command or press **Ctrl-Z**.

3.3.2 Router Configuration Mode

Router configuration commands are used to configure an IP routing protocol and always follow a **router** command. To list the available router configuration keywords, enter the **router** command followed by a space and a question mark (**?**) at the global configuration prompt.

```
Router(config)# router ?
  ospf   Open Shortest Path First
  rip    Routing Information Protocol (RIP)
Router(config)# router
```

In the following example, the router is configured to support the Routing Information Protocol (RIP). The new prompt is *`Router(config-rip-router)#`*.

```
Router(config)# router rip
Router(config-rip-router)# ?
  default-information  Control distribution of default route
```

```
  default-metric       Set a metric of redistribute routes
  distance             Administrative distance
  distribute-list      Filter networks in routing updates
  end                  End current mode and change to enable mode
  exit                 Exit current mode and down to previous mode
  help                 Description of the interactive help system
  neighbor             Specify a neighbor router
  network              Enable routing on an IP network
  no                   Negate a command or set its defaults
  offset-list          Modify RIP metric
  passive-interface    Suppress routing updates on an interface
  quit                 Exit current mode and down to previous mode
  redistribute         Redistribute information from another routing protocol
  show                 Show running system information
  timers               Adjust routing timers
  version              Set routing protocol version
  write                Write running configuration to memory, network, or terminal
```

To exit router configuration mode and return to global configuration mode, enter the **exit** command. To exit configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.

3.3.3 Route-Map Configuration Mode

Use the route-map configuration mode to configure the routing table and the source and destination information. To access and list the route-map configuration commands, use the **route-map** command in global configuration mode.

In the following example, a route map named *mymap* is configured. The new prompt is *Router(config-route-map)#*. Enter a question mark (**?**) to list **route-map** configuration commands.

```
Router(config)# route-map mymap permit 30
Router(config-route-map)# ?
  end        End current mode and change to enable mode
  exit       Exit current mode and down to previous mode
  help       Description of the interactive help system
  match      Match values from routing table
  no         Negate a command or set its defaults
  on-match   Exit policy on matches
  quit       Exit current mode and down to previous mode
  route-map  Create route-map or enter route-map command mode
  set        Set values in destination routing protocol
  show       Show running system information
  write      Write running configuration to memory, network, or terminal
```

To exit route-map configuration mode and return to global configuration mode, enter the **exit** command. To exit configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.

3.4 Advanced Features Supported within the Command Mode

Entering a question mark (?) at the system prompt displays a list of commands available for each command mode. You can also get a list of any command's associated keywords and arguments with the context-sensitive help feature.

To get help specific to a command mode, a command, a keyword, or an argument, perform one of the following commands:

Command	Purpose
help	Obtain a brief description of the help system in any command mode.
?	List all commands available for a particular command mode.

When using context-sensitive help, the space (or lack of a space) before the question mark (?) is significant. To obtain a list of commands that begin with a particular character sequence, type in those characters followed immediately by the question mark (?). Do not include a space. This form of help is called word help, because it completes a word for you.

To list keywords or arguments, enter a question mark (?) in place of a keyword or argument. Include a space before the question mark (?). This form of help is called command syntax help, because it reminds you which keywords or arguments are applicable based on the command, keywords, and arguments you already have entered.

You can abbreviate commands and keywords to the number of characters that allow a unique abbreviation. For example, you can abbreviate the **configure terminal** command to **config term**, or even **con t**. Because the shortened form of the command is unique, the router will accept the shorted form and execute the command.

Enter the **help** command (which is available in any command mode) for a brief description of the help system:

```
Router# help
CLI/VTY provides advanced help feature.  When you need help,
anytime at the command line please press '?'.
If nothing matches, the help list will be empty and you must backup until entering a
'?' shows the available options.
Two styles of help are provided:
1. Full help is available when you are ready to enter a command argument (e.g. 'show
?') and describes each possible argument.
2. Partial help is provided when an abbreviated argument is entered and you want to
know what arguments match the input (e.g. 'show cl?'.)
Router# show cl?
 clock  Display the system clock
Router# show cl
```

As described in the help command output, you can enter a partial command name and a question mark (?) to obtain a list of commands beginning with a particular character set.

Example of Context Sensitive Help

The following example illustrates how the context-sensitive help feature creates an access list from the configuration mode.

Enter the letters “co” at the system prompt followed by a question mark (?). Do not leave a space between the last letter and the question mark (?). The system provides the commands that begin with *co*.

```
Router# co?
  configure  Enter configuration mode
  copy       Copy from one file to another
Router# co
```

Enter the **configure** command followed by a space and a question mark (?) to list the command’s keyword(s) and a brief explanation:

```
Router# configure ?
```

```
  terminal  Configure from the terminal
```

Note that in the example below, if you enter the configure command followed by the Carriage Return (Enter or Return key), you will be prompted that the command is incomplete.

```
Router# configure
% Command incomplete.
Router#
```

Generally, uppercase letters represent variables. For example, after entering a command, such as **hostname**, and using a space and a question mark, you will be prompted for the new name, represented by WORD. In cases where an IP address is the variable, the uppercase letters A.B.C.D will represent it.

```
Router(config)# hostname ?
  WORD  This system's network name
```

In the access list example below, two further options are listed after the question mark. You may enter an optional source wildcard. The carriage return symbol (<cr>) indicates a carriage return is needed to enter the command. More information on access lists is found in Chapter 5.

```
Router(config)# access-list 99 deny 192.168.123.0 ?
  A.B.C.D Source wildcard. e.g. 0.0.0.255
  <cr>
Router(config)# access-list 99 deny 192.168.123.0
```

3.5 Checking Command Syntax

The CLI user interface provides an error indicator, a caret symbol (^). The caret symbol appears at the point in the command string where you have entered an incorrect letter, command, keyword, or argument.

In the following example, suppose you want to enable rip router:

```
Router(config)# routed rip
                ^
  % Invalid input detected at '^' marker.
```

There is no command starting with “routed”, so the first invalid input is “d.” Hence, the indicated caret symbol (^) marks the invalid input.

```
Router(config)# route
 % Ambiguous command.
Router(config)#
```

In the example above, a command has been issued that is unknown or ambiguous.

```
Router(config)# router
 % Command incomplete.
Router(config)#
```

In the example above, a command has been issued that is incomplete. In the following examples, various correct commands (using *route*) are displayed.

```
Router(config)# route?
 route-map   Create route-map or enter route-map command mode
 router      Enable a routing process
Router(config)# route
```

```
Router(config)# router ?
  bgp    BGP information
  ospf   Open Shortest Path First
  rip    Routing Information Protocol (RIP)
Router(config)# router
Router(config)#router rip
Router(config-rip-router)#
```

3.6 Using CLI Command History

The CLI user interface provides a history or record of commands that you have entered. This feature is particularly useful for recalling long or complex commands or entries, including access lists. To recall commands from the history buffer, use one of the following commands:

Keystrokes/Command	**Purpose**
Press **Ctrl-P** or the up arrow key	Recall commands in the history buffer, beginning with the most recent command. Repeat the key sequence to recall successively older commands.
Press **Ctrl-N** or the down arrow key	Return to more recent commands in the history buffer after recalling commands with Ctrl-P or the up arrow key. Repeat the key sequence to recall successively more recent commands.
show history	While in EXEC mode, list the last several commands entered.

3.7 Using the No and Default Forms of Commands

Almost every router configuration command has an opposite **no** form that negates or reverses a command. In general, the **no** form is used to disable a function that has been enabled. To re-enable a disabled function, or to enable a function that is disabled by default, use the command without the **no** keyword. For example, Address Resolution Protocol (ARP) is enabled by default. Specify the command **no arp** to disable the ARP table; to re-enable the ARP table, use the **arp** command.

3.8 Using Command-Line Editing Features and Shortcuts

A variety of shortcuts and editing features are enabled for the CLI command-line interface. The following subsections describe these features:

- Moving Around on the Command Line
- Completing a Partial Command Name
- Editing Command Lines that Wrap
- Deleting Entries
- Scrolling Down a Line or a Screen
- Redisplaying the Current Command Line

- Transposing Mistyped Characters
- Controlling Capitalization

3.8.1 Moving Around on the Command Line

Use the following keystrokes to move the cursor around on the command line in order to make corrections or changes:

Keystrokes	Purpose
Press **Ctrl-B** or the left arrow.	Move the cursor back one character.
Press **Ctrl-F** or the right arrow.	Move the cursor forward one character.
Press **Ctrl-A**.	Move the cursor to the beginning of the command line.
Press **Ctrl-E**.	Move the cursor to the end of the command line.
Press **Esc B**.	Move the cursor back one word.
Press **Esc F**.	Move the cursor forward one word.

Note: The arrow keys function only on ANSI-compatible terminals such as VT100s.

3.8.2 Completing a Partial Command Name

If you cannot remember a complete command name, press the **Tab** key to allow the system to complete a partial entry.

Keystrokes	Purpose
Enter the first few letters and press **Tab**.	Complete a command name.

If your keyboard does not have a Tab key, press Ctrl-I instead.

In the following example, when you enter the letters “conf” and press the **Tab** key, the system provides the complete command:

```
Router# conf<Tab>
Router# configure
```

The command is not immediately executed, so that you may modify the command if necessary. If you enter a set of characters that could indicate more than one command, the system simply lists all possible commands.

You may also enter a question mark (?) to obtain a list of commands that begin with that set of characters. Do not leave a space between the last letter entered and the question mark (?). For example, three commands in privileged mode start with *co*. To see what they are, type **co?** at the privileged EXEC prompt:

```
Router# co?
configure
copy
Router# co
```

3.8.3 Editing Command Lines That Wrap

The enhanced editing feature provides a wraparound for commands that extend beyond a single line on the screen. When the cursor reaches the right margin, the command line shifts 8 spaces to the left. You cannot see the first eight characters of the line, but you can scroll back and check the syntax at the beginning of the command. To scroll back, use the following command:

Keystrokes	Purpose
Press **Ctrl-B** or the left arrow repeatedly until you scroll back to the beginning of the command entry, or press **Ctrl-A** to return directly to the beginning of the line.	Return to the beginning of a command line to verify that you have correctly entered a lengthy command.

Note: The arrow keys function only on ANSI-compatible terminals such as VT100.

In the following example, the access-list command entry extends beyond one line. When the cursor first reaches the end of the line, the line is shifted 8 spaces to the left and redisplayed. The dollar sign ($) indicates that the line has been scrolled to the left. Each time the cursor reaches the end of the line, it is again shifted 8 spaces to the left.

```
Router(config)# access-list 101 permit icmp 192.168.123.0 0.0.0.255 192
Router(config)# $ st 101 permit icmp 192.168.123.0 0.0.0.255 192.168.0.1
```

When you have completed the entry, press **Ctrl-A** to check the complete syntax before pressing **Enter** to execute the command. The dollar sign ($) appears at the end of the line to indicate that the line has been scrolled to the right:

```
Router(config)# access-list 101 permit icmp 192.168.123.0 0.0.0.255 192$
```

Use line wrapping in conjunction with the command history feature to recall and modify previous complex command entries.

3.8.4 Deleting Entries

Use any of the following commands to delete command entries if you make a mistake or change your mind:

Keystrokes	Purpose
Press **Delete** or **Backspace**.	Erase the character to the left of the cursor.
Press **Ctrl-D**.	Delete the character at the cursor.
Press **Ctrl-K**.	Delete all characters from the cursor to the end of the command line.
Press **Ctrl-U** or **Ctrl-X**.	Delete all characters from the cursor to the beginning of the command line.
Press **Ctrl-W**.	Delete the word to the left of the cursor.
Press **Esc D**.	Delete from the cursor to the end of the word.

3.8.5 Scrolling Down a Line or a Screen

When using a command that list more information than will fill on the screen, the prompt --*More*-- is displayed at the bottom of the screen. Whenever the *More* prompt is displayed, use the following keystrokes to view the next line or screen:

Keystrokes	**Purpose**
Press **Return**.	Scroll down one line.
Press **Spacebar**.	Scroll down one screen.

3.8.6 Redisplaying the Current Command Line

If you are entering a command and the system suddenly sends a message to your screen, you can easily recall your current command line entry. To do so, use the following command:

Keystrokes	**Purpose**
Press **Ctrl-L** or **Ctrl-R**.	Redisplay the current command line.

3.8.7 Transposing Mistyped Characters

If you have mistyped a command entry, you can transpose the mistyped characters by using the following command:

Keystrokes	**Purpose**
Press **Ctrl-T**.	Transpose the character to the left of the cursor with the character located at the cursor.

3.8.8 Controlling Capitalization

You can toggle between uppercase and lowercase letters with simple keystroke sequences. To do so, use the following command:

Keystrokes	**Purpose**
Press **Esc C**.	Capitalize at the cursor. Press **Esc C** or **Alt-C** again to return to lowercase letters.

3.9 Passwords and Privileges Commands

The following sections describe the password and privileges commands used to control access to different levels of the router:

- Enable Password
- Password
- Service Password-Encryption

3.9.1 Enable Password

To set a local password to control access to various privilege levels, use the **enable password** command in global configuration mode. Use the **no** form of this command to remove the password requirement.

```
Router(config)# enable password ?
  0     Specifies an UNENCRYPTED password will follow
  7     Specifies a HIDDEN password will follow
  LINE  The UNENCRYPTED (cleartext) 'enable' password
Router(config)# enable password 0 <password>
Router(config)# exit
Router# write [memory  file]
```

3.9.2 Password

To specify a password on a line, use the **password** command in line configuration mode. Use the **no** form of this command to remove the password.

```
Router(config)# line ?
  console  Primary terminal line
  vty      Virtual terminal
Router(config)# line console ?
  <0-0>  Line number
Router(config)# line console 0
Router(config-line)# ?
  end           End current mode and change to enable mode
  exec-timeout  Set timeout value
  exit          Exit current mode and down to previous mode
  help          Description of the interactive help system
  no            Negate a command or set its defaults
  password      Set a password
  quit          Exit current mode and down to previous mode
Router(config-line)# password ?
  LINE  The UNENCRYPTED (cleartext) line password
  0     Specifies an UNENCRYPTED line password will follow
  7     Specifies a HIDDEN line password will follow
Router(config-line)# password Asante
Router(config-line)# end
Router# write ?
  file      Write to configuration file
  memory    Write configuration to the file (same as write file)
  terminal  Write to terminal
Router# write file
Writing current-config to startup-config, Please wait...
Configuration saved to startup-config file
Router#
```

3.9.3 Service Password-Encryption

To encrypt passwords, use the **service password-encryption** command in global configuration mode. Use the **no** form of this command to restore the default.

```
Router(config)# service password-encryption
Router(config)# no service password-encryption
```

Chapter 4: Managing the System and Configuration Files

This chapter explains how to manage the system information, as well as how to manage the configuration files for the IC35516.

4.1 Managing the System

This section discusses the following tasks needed to manage the system information of the IC35516:

- Setting the System Clock
- Configuring the Host name
- Changing the Password
- Testing Connections with Ping Commands
- Tracing Packet Routes
- Enabling Syslog
- Displaying the Operating Configuration

4.1.1 Setting the System Clock

The IC35516 has a battery-backed system clock that will remain accurate even after a system restart.

To manually set the system clock, complete the following commands in privileged mode. Use a space and a question mark (?) to display the clock set options. Restart the system after configuring the clock by typing **reload** at the *Router#* prompt and pressing **Enter**.

```
Router# clock ?
  set  Set the time and date
Router# clock set ?
  HH:MM:SS  Current Time
Router# clock set 09:29:30 ?
  <1-31>  Day of the month
Router# clock set 09:29:30 28?
  <1-31>  Day of the month
Router# clock set 09:29:30 28 ?
  MONTH  Month of the year (for example: June or July)
Router# clock set 09:29:30 28 January ?
  <1970-2069>  Year
Router# clock set 09:29:30 28 January 2004
Router# reload <cr>
```

4.1.2 Specify the Hostname

The factory-assigned default host name is **Router**. To specify or modify the host name for the network, use the **hostname** global configuration command.

Command	Purpose

hostname *name*	New host name for the network.

4.1.3 Changing the Password

The switch ships with a default of no password, which allows immediate access to ANYONE on the network. In order to guard against unauthorized access, only the administrator should be allowed to change the password. A new password is prompted for twice to avoid any typing mistakes. The new password must have more than five characters, and less than eight characters. **The password is case sensitive**.

To change the password, use the following command in global configuration mode.

Keystrokes	**Purpose**
enable password	Change the password.

4.1.4 Trace Packet Routes

To discover the routes that packets will actually take when traveling to their destinations, use the following command in top mode.

Command	**Purpose**
tracert *address*	Trace packet routes through the network.

4.1.5 Test Connections with Ping Tests

The switch supports IP ping, which can be used to test connectivity to remote hosts, via their IP addresses. Ping sends an echo request packet to an address and “listens” for a reply. The ping request will receive one of the following responses:

- Normal response—The normal response occurs in 1 to 10 seconds, depending on network traffic
- Request timed out—There is no response, indicating a connection failure to the host, or the host has discarded the ping request

Beginning in privileged EXEC mode, use this command to ping another device on the network from the switch:

Command	**Purpose**
ping *address*	Send an ICMP echo message to a designated host for testing connectivity.

4.1.6 Enable the System Log

The IC35516 can send syslog messages to manager servers. Syslog messages are collected by a standard UNIX or NT type syslog daemon.

Syslog enables the administrator to centrally log and analyze configuration events and system error messages such as interface status, security alerts, environmental conditions, and CPU process overloads.

To log messages, use the following command in global configuration mode.

Command	Purpose
logging *address*	IP address of the host to be used as a syslog server.
logging facility	Facility parameters for syslog messages.
logging trap	Set syslog server logging level.

4.1.7 Displaying the Operating Configuration

The configuration file may be displayed from the EXEC (enable) mode.

To see the current operating configuration, enter the following command at the enable prompt:

```
Router# show running-config
```

To see the configuration in NVRAM, enter the following command:

```
Router# show startup-config
```

If you made changes to the configuration, but did not yet write the changes to NVRAM, the results of **show running-config** will differ from the results of **show startup-config**.

4.2 Managing Configuration Files

This section discusses how to download configuration files from remote servers, and store configuration files on the router at system startup.

Configuration files contain the commands the router uses to customize the function of the IC35516. The setup command facility helps you create a basic configuration file. However, you can manually change the configuration by typing commands in a configuration mode.

Startup configuration files are used during system startup to configure the software. Running configuration files contain the current configuration of the software. The two configuration files can be different. For example, you may want to change the configuration for a short period rather than permanently. In this case, you would change the running configuration using the **configure terminal** command, but not save the configuration using the **copy running-config startup-config** command. To change the startup configuration, you can either save the running configuration file to the startup configuration using the **copy running-config startup-config** command, or copy commands from a file server to the startup configuration (**copy tftp startup config** command) without affecting the running configuration.

4.2.1 Configuring from the Terminal

The configuration files are stored in the following places:

- The running configuration is stored in RAM
- The startup configuration is stored in nonvolatile random-access memory (NVRAM)

To enter the configuration mode, enter the **configure terminal** command at the privileged EXEC prompt. The software accepts one configuration command per line. You can enter as many configuration commands as you want.

You can add comments to a configuration file describing the commands you have entered. Precede a comment with an exclamation point (!).

Use the following commands to configure the software from the terminal.

Command	Purpose
configure terminal	Enters global configuration mode and select the terminal option.
Router(config)#	The global configuration prompt. Enter the necessary configuration commands.
copy running-config startup-config	Saves the configuration file to your startup configuration. On most platforms, this step saves the configuration to NVRAM.
end or press **Ctrl-Z** (**^Z**)	Exits global configuration mode.

In the following example, the **hostname** command is used to change the hostname from "Router" to "new_name". By pressing Ctrl-Z (^Z) or entering the **end** command, you quit[1] the global configuration mode. Finally, the **copy running-config startup-config** command saves the current configuration to the startup configuration.

```
Router# configure terminal
Router(config)# hostname new_name
new_name(config)# end
new_name# copy running-config startup-config
```

When the startup configuration is in NVRAM, it stores the current configuration information in text format as configuration commands, recording only non-default settings. The memory is checksummed to guard against corrupted data.

4.2.2 Copying Configuration Files to a Network Server

You can copy configuration files from the router to a file server using TFTP. You might wish to back up a current configuration file to a server before changing its contents, thereby allowing you to later restore the original configuration file from the server.

Important! TFTP is not a secure protocol. Your server IP address and configuration file name will not be protected over the public Internet. Use TFTP only on a trusted LAN connection.

To specify that the running or startup configuration file be stored on a TFTP network server, use the following commands in the EXEC mode. (**Note**: Copying the startup configuration file to the current running configuration merges the two files. It is recommended that you keep a copy of the start-up configuration file before merging the two in case you want to revert back to the original startup configuration).

```
Router# copy startup-config ?
  running-config             Update (merge with) current system configuration
  tftp:[//A.B.C.D/filename]  Copy to tftp: file system
```

OR

```
Router# copy running-config ?

  startup-config             Copy to startup configuration
  tftp:[//A.B.C.D/filename]  Copy to tftp: file system
Router# copy running-config tftp
Enter TFTP Server IP Address [A.B.C.D]?
Enter file name 'my-config' to copy?
```

Reply to any prompts for additional information or confirmation. The prompts will depend on how much information has been provided in the copy command and the current setting of the file prompt command.

The command can also look like this example:

```
Router# copy running-config tftp://192.168.0.1/my-config
Upload file 'my-config' to 192.168.0.1 from running-config? [y/n] y
Accessing tftp://192.168.0.1/my-config...
[OK] 487 bytes copied in time <1 sec
```

4.2.3 Copying Configuration Files from a Network Server to the IC35516

You can copy configuration files from a TFTP server to the running configuration or startup configuration of the router. You may want to do this for one of the following reasons:

1. To restore a previously backed up configuration file.

2. To use the same configuration file for another router. For example, you may add another router to your network and want it to have a similar configuration to the original router. By copying the file to the new router, you can change the relevant parts rather than re-creating the whole file.

3. To load the same configuration commands onto all the routers in your network so that they all have the same configurations.

The **copy tftp running-config** command loads the configuration files into the router as if you were typing the commands in at the command line. The router does not erase the existing running configuration before adding the commands unless a command in the copied configuration file replaces a command in the existing configuration file. For example, if the copied configuration file contains a different IP address in a particular command than the existing configuration, the IP address in the copied configuration will be used. However, some commands in the existing configuration may not be replaced or negated. In this case, the resulting configuration file will be a mixture of the existing configuration file and the copied configuration file, with the copied configuration file having precedence.

In order to restore a configuration file to an exact copy of a file stored on a server, you need to copy the configuration file directly to the startup configuration (using the **copy tftp startup-config** command) and reload the router.

To copy a configuration file from a TFTP server to the router, use one of the following commands in EXEC mode:

Command	**Purpose**
copy tftp:[[[//location]/directory]/filename] **running-config** **copy tftp:**[[[//location]/directory]/filename] **startup-config**	Copy a file from a TFTP server to the router.

Reply to any router prompts for additional information or confirmation. Additional prompts will depend on how much information is provided in the copy command and the current setting of the file prompt command.

In the following example, the software is configured from the file my-config at IP address 192.168.123.59:

```
Router# copy tftp://192.168.123.59/my-confg running-config
Download file 'my-config' from 192.168.123.59 to running-config? [y/n] y
Accessing tftp://192.168.123.59/my-config...
[OK] 487 bytes copied in time <1 sec
Updating running-config...
```

To clear the saved configuration, use the following command from privileged mode:

```
Router# erase startup-config
```

4.3 Configuring SNMP and Spanning Tree

This section discusses the following tasks needed to configure Simple Network Management Protocol (SNMP) and Spanning Tree Protocol (STP).

4.3.1 Configuring SNMP Support

The Simple Network Management Protocol (SNMP) system consists of three parts: an SNMP manager, an SNMP agent, and a Management Information Base (MIB). SNMP is an application-layer protocol that allows SNMP manager and agent stations to communicate. SNMP provides a message format for sending information between an SNMP manager and an SNMP agent. The agent and MIB reside on the router. In configuring SNMP on the router, the relationship between the manager and the agent must be defined.

The *SNMP agent* gathers data from the *MIB*, which holds the information about device parameters and network data. The agent also responds to the manager's requests to get or set data. An agent can also send unsolicited traps to the manager. Traps are messages alerting the SNMP manager to a specific event on the network. Such events include improper user authentication, restarts, link status (up or down), closing of a TCP connection, or loss of connection to a neighboring router. An *SNMP manager* can request a value from an agent, or store or change a value in that agent.

To configure support for SNMP on the router, perform the following tasks:

- Create or Modify Access Control for SNMP Community
- Establish the Contact and Location of SNMP Agent
- Define SNMP Trap Operations
- Disable the SNMP Agent

Create or Modify Access Control for SNMP Community

You can configure a community string, which acts like a password, to permit access to the agent on the router.

- **Read Only (ro)**: The string that defines access rights for reading SNMP data objects. The default is **public**.
- **Read-Write (rw)**: The string that defines access rights for writing SNMP data objects. The default is **private**.

Important! Be sure to change the SNMP default community strings in order to prevent unauthorized access to management information.

To set up the community access string to permit access to the SNMP, use the following command from the global command mode.

Command	Purpose
snmp-server community *string* [**view** *view-name*] {**ro** | **rw**} [*access-list-number*]	Define the community access string. The *access-list-number* parameter is numbered from 1–99 and 1300–1999.

Establish the Contact and Location of the SNMP Agent

Set the system contact and the location of the SNMP agent so that these descriptions can be accessed through the configuration file.

To set the system contact (sysContact) string, use the following command in global configuration command.

Command	Purpose
snmp-server contact *text*	Set the system contact string.
snmp-server location *text*	Set the system location string.

Define SNMP Trap Operations

A trap is an unsolicited message sent by an SNMP agent to an SNMP manager indicating that some event has occurred. The SNMP trap operations let you configure the router to send information to a network management application when a particular event occurs.

To define traps for the agent to send to the manager, use the following commands in global configuration mode.

Command	Purpose
snmp-server host *address* [**traps|informs**] [**version** {**1|2c|3** [**auth|noauth|priv**]}] *community-string* [**udp-port** *port-number*]	Specify the recipient of the trap message. Traps and informs are not currently supported for SNMPv3.

The 35516 can send an SNMP trap to its configured trap receivers if it detects a duplicate IP address. To turn on duplicate IP detection, use the following command in global configuration mode:

Command	Purpose
duplicate-ip detect	Enable duplicate IP detection.

Disable the SNMP Protocol

To disable SNMP, use the following command in global configuration mode:

Command	Purpose
no snmp-server	Disable SNMP operation. This command disables all versions

	of the SNMP agent.

4.3.2 Other SNMP Configuration

Command	Purpose
snmp-server	Enable the SNMP agent. The first ***snmp-server*** global configuration command enables SNMP.
snmp-server engineID {**local** *engineid-string*|**remote** *host-ip-address* [**udp-port** *port-number*] *engineid-string*}	Set Engine ID for local or remote devices. The remote engine ID is used to create users that can send SNMPv3 traps.
snmp-server view *view-name subtree* [*subtree-mask*] [**included | excluded**]	Define the SNMP server view. Currently, the SNMP *subtree* can only adopt numbered form. That is, "1.3.6.1.2.1" is valid but "mib-2" is invalid. The *subtree-mask* uses colon-separated hex digits, such as "FF:A0".
snmp-server group *group-name* {**v1 | v2c | v3** [**auth | noauth | priv**]} [**read** *read-view*] [**write** *write-view*] [**notify** *notify-view*] [**access** *access-list*]	Set SNMP views. The default read-view is "*all*," and the default write-view and notify-view are "none". (Currently, "**v3 priv**" is not supported.)
snmp-server user *user-name group-name* [**remote** *host-ip-address* [**udp-port** *port-number*]] {**v1|v2c|v3** [**auth** {**md5 | sha**} *auth-password*]} [**encrypted**] [**access** *access*-list]	Define SNMP server users. (Currently creating "**v1|v2**" users and the "**sha**"(SHA1) algorithm are not supported)
snmp-server enable traps [snmp authentication | duplicate-ip | station-move]	Enable SNMP traps. Supported trap types are authentication, duplicate-ip, and station-move.
snmp-server trap-source *interface-name*	Use specified *veth*'s primary IP address as the source address when sending traps and informs.
snmp-server trap-timeout *seconds*	Define how often to resend trap messages. The range is 1–1000. The default is 30 seconds.
snmp-server queue-length *length*	Set the message queue length for each trap-host. The range is 1–1000. The default is 10.
snmp-server contact *text*	Set the system contact string.
snmp-server location *text*	Set the system location string.
show snmp **show snmp engineID** [**local | remote**] **show snmp groups** **show snmp user**	Show various SNMP information.

4.3.3 Configuring Spanning Tree Protocol (STP)

The Spanning Tree Protocol (STP) is part of the IEEE 802.1D standard. It provides for a redundant network without the redundant traffic through closed paths. For example, in a network without spanning tree protocol, the same message will be broadcast through multiple paths, which may start an unending packet-passing cycle. This in turn causes a great amount of extra network traffic, leading to network downtime. The STP reduces a network like this, with multiple, redundant connections, to one in which all points are connected, but where there is only one path between any two points (the connections span the entire network, and the paths are branched, like a tree).

All of the bridges (a switch is a complex bridge) on the network communicate with each other using special packets of data called Bridge Protocol Data Units (BPDUs). The information exchanged in the BPDUs allows the bridges on the network to do the following:

- Elect a single bridge to be the root bridge
- Calculate the shortest path from each bridge to the root bridge
- Select a designated bridge on each segment, which lies closest to the root and forwards all traffic to it
- Select a port on each bridge to forward traffic to the root
- Select the ports on each bridge that forward traffic, and place the redundant ports in blocking states

Spanning Tree Parameters

The operation of the spanning tree algorithm is governed by several parameters. You can configure the following parameters from global configuration mode: forward-time, hello-time, max-age, and priority.

```
Router(config)# spanning-tree ?
  forward-time  Set forwarding delay time
  hello-time    Set interval between HELLOs
  max-age       Maximum allowed message age of received Hello BPDUs
  priority      Set bridge priority
  rapid         Enable rapid convergence
  <cr>
Router(config)# spanning-tree
```

Forward Time

After a recalculation of the spanning tree, the Forward Time parameter regulates the delay before each port begins transmitting traffic. If a port begins forwarding traffic too soon (before a new root bridge has been selected), the network can be adversely affected. The default value for Forward Time is 15 seconds.

Hello Time

This is the time period between BPDUs transmitted by each bridge. The default setting is 2 seconds.

Maximum Age

Each bridge should receive regular configuration BPDUs from the direction of the root bridge. If the maximum age timer expires before the bridge receives another BPDU, it assumes that a change in the topology has occurred, and it begins recalculating the spanning tree. The default setting for Maximum Age is 20 seconds.

Note: The above parameters (Hello Time, Maximum Age, and Forward Time) are constrained by the following formula:

(Hello Time + 1) <= Maximum Age <= 2 x (Forward Delay – 1)

Priority

Setting the bridge priority to a low value will increase the likelihood that the current bridge will become the root bridge. If the current bridge is located physically near the center of the network, decrease the Bridge Priority from its default value of 32768 to make it become the root bridge. If the current bridge is near the edge of the network, it is best to leave the value of the Bridge Priority at its default setting.

In general, reducing the values of these timers will make the spanning tree react faster when the topology changes, but may cause temporary loops as the tree stabilizes in its new configuration. Increasing the values of these timers will make the tree react more slowly to changes in topology, but will make an unintended reconfiguration less likely. All of the bridges on the network will use the values set by the root bridge. It is only necessary to reconfigure that bridge if changing the parameters.

Spanning Tree Port Configuration

You can configure the following parameters from interface configuration mode:

```
Router(config)# interface eth1
Router(config-if-eth1)# spanning-tree ?
  disable        Disable spanning tree protocol in this interface
  edg  e-port      Enable port admin edge
  link-type      Configure the link type
  path-cost      Set interface path cost
  port-priority  Set interface priority
Router(config-if-eth1)#
```

Port Priority

The port priority is a spanning tree parameter that ranks each port, so that if two or more ports have the same path cost, the STP selects the path with the highest priority (the lowest numerical value). By changing the priority of a port, it can be more, or less, likely to become the root port. The default value is 128, and the value range is 0–255.

Port Path Cost

Port path cost is the spanning tree parameter that assigns a cost factor to each port. The lower the assigned port path cost is, the more likely that port will be accessed. The default port path cost for a 10 Mbps or 100 Mbps port is the result of the equation:

Path cost = 1000/LAN speed (in Mbps)

Therefore, for 10 Mbps ports, the default port path cost is 100. For 100 Mbps ports, it is 10. To allow for faster networks, the port path cost for a 1000 Mbps port is set by the standard at 4.

4.3.4 Rapid Spanning Tree Protocol (RSTP)

Rapid Spanning Tree Protocol makes use of point-to-point link type and expedites into a rapid convergence of the spanning tree. Re-configuration of the spanning tree can occur in less than 1 second (as opposed to 50 seconds with the default settings in the legacy spanning tree), which is critical for networks carrying delay-sensitive traffic, such as voice and video.

Port Roles and the Active Topology

RSTP provides rapid convergence of the spanning tree by assigning port roles and by determining the active topology. RSTP uses the same underlying spanning tree calculation and algorithm as legacy STP to select the bridge with the highest bridge priority (lowest numerical priority value) as the root bridge. Then RSTP assigns one of these port roles to bridge ports:

- Root port—provides the best path (lowest cost) when the bridge forwards packets to the root switch.
- Designated port—connects to the designated switch, which has the lowest path cost when forwarding packets from that LAN to the root bridge. The port through which the designated switch is attached to the LAN is called the designated port.
- Alternate port—offers an alternate path toward the root switch to that provided by the current root port.
- Backup port—acts as a backup for the path provided by a designated port toward the leaves of the spanning tree. A backup port can exist only when two ports are connected together in a loop-back by a point-to-point link or when a switch has two or more connections to a shared LAN segment.
- Disabled port—has no role in the operation of the spanning tree.

A port with the root or a designated port role is included in the active topology. A port with the alternate or backup port role is excluded from the active topology.

Rapid Convergence

RSTP provides for rapid recovery of connectivity following the failure of a switch, switch port, or LAN. It provides rapid convergence for edge ports, new root ports, and ports connected through point-to-point links as follows:

- Edge ports—If a port on a switch running RSTP is assigned to be a edge port, it will be put to forwarding immediately. However, the edge port will be in the RSTP initialization state and will send out the RSTP BPDUs with the operating status of edge port set to TRUE. If the edge port starts receiving the BPDUs, it will change the operating edge state to FALSE and start the spanning tree calculations. It is recommended to assign any ports that are to be left as a “leaf” of the LAN (with no connection to any bridge) as edge ports.
- Root ports—If the RSTP selects a new root port, it blocks the old root port and immediately transitions the new root port to the forwarding state.
- Point-to-point links—If you connect a port to another port through a point-to-point link and the local port becomes a designated port, it negotiates a rapid transition with the other port by using the proposal-agreement handshake to ensure a loop-free topology.

Note that if the link type of the port is not forced, the switch makes the decision of link type by operating duplex mode of the port. Also, a port with full-duplex mode is considered as a point-to-point link type, and a port in half-duplex mode is set as shared link type.

Enabling Rapid Spanning Tree

Use the **spanning-tree rapid** configuration mode command to enable rapid spanning tree on the switch.

Use the **no** form of the command to disable the rapid spanning tree. Note that by default, spanning mode will be legacy 802.1D spanning, If **no spanning-tree rapid** is used, it will change the mode to legacy 802.1D spanning tree.

Configuring Switch/Bridge Priority

Use the following configuration mode command to set the switch/bridge priority:

```
Router(config)# spanning-tree priority <priority>
```

For <*priority*> the range is 0 to 61440 in increments of 4096; the default is 32768. The lower the number, the more likely the switch will be chosen as the root switch.

Valid priority values are 0, 4096, 8192, 12288, 16384, 20480, 24576, 28672, 32768, 36864, 40960, 45056, 49152, 53248, 57344, and 61440. All other values are rejected.

To return the switch to its default setting, use the **no spanning-tree priority** configuration command.

Restarting the Protocol Migration Process

A switch when running RSTP supports a built-in protocol migration mechanism that enables it to interoperate with legacy 802.1D switches. If this switch receives a legacy 802.1D configuration BPDU (a BPDU with the protocol version set to 0), it sends only 802.1D BPDUs on that port. To restart the protocol migration process (force the re-negotiation with neighboring switches) on the entire switch, you can use the **clear spanning-tree detected-protocols** enable mode command. Use the **clear spanning-tree detected-protocols interface** *interface-id* enable mode command to restart the protocol migration process on a specific interface.

Configuring Link Type

Use the following interface mode command to configure port link-type:

```
Router(config)# interface eth1
Router(config-if-eth1)#spanning-tree link-type {point-to-point|shared}
```

By default, the link type is determined from the duplex mode of the interface: a full-duplex port is considered to have a point-to-point connection; a half-duplex port is considered to have a shared connection.

To return the switch to its default setting, use the **no spanning-tree link-type** interface configuration command.

Configuring an Edge Port

Use the following interface mode command to configure port link type:

```
Router(config)# interface eth1
Router(config-if-eth1)#spanning-tree edge-port
```

The default setting is no edge port configuration.

To return the switch to its default setting, use the **no spanning-tree edge-port** interface configuration command.

Configuring Port Path Cost

Use the following interface mode command to configure port path cost:

```
Router(config)# interface eth1
Router(config-if-eth1)#spanning-tree path-cost <path-cost>
```

The default values for path cost is determined by the operating port speed:

- For ports operating in 1000Mb speed, the path cost is 20000
- For ports operating in 100Mb speed, the path cost is 200000
- For ports operating in 10Mb speed, the path cost is 2000000

To return the switch to its default setting, use the **no spanning-tree path-cost** interface configuration command.

Configuring port priority

Use the following interface mode command to configure port priority:

```
Router(config)# interface eth1
Router(config-if-eth1)#spanning-tree port-priority <port-priority>
```

For <*port-priority*>, the range is 0–240 in increments of 16; the default is 128. The lower the number, the higher the priority.

To return the switch to its default setting, use the **no spanning-tree port-priority** interface configuration command.

4.4 MAC Address Table

The MAC Address Table is a table of node addresses that the switch automatically builds by "learning." It performs this task by monitoring the packets that pass through the switch, checking the source and destination addresses, and then recording the source address information in the table. To see the table, type the following command in privileged mode:

```
Router# show mac-address-table
Vlan    Mac Address             Type    Ports
----    -----------------       ----    -----
3       00:00:1C:01:00:09       Dynamic eth13
1       00:00:94:00:00:10       Dynamic eth9
1       00:00:94:A0:B6:7B       Dynamic eth9
1       00:00:94:AA:64:37       Dynamic eth9
1       00:00:94:D2:53:79       Dynamic eth9
--      00:00:94:D2:56:EA       Self    --
1       00:0A:27:AE:50:66       Dynamic eth9
1       00:50:FC:94:00:0D       Dynamic eth9
```

The switch uses the information in this table to decide whether a frame should be forwarded to a particular destination port or "flooded" to all ports other than to the received port. Each entry consists of three parts: the MAC address of the device, the port number on which it was received, and the VLAN number.

By default, entries in the switch's MAC address table are aged out after 300 seconds. To change this value, use the following command in global configuration mode:

```
Router(config)# mac-address-table aging-time
```

The range is 10–1,000,000 seconds. A value of 0 disables aging.

Chapter 5: Configuring IP

The Internet Protocol (IP) is a packet-based protocol used to exchange data over computer networks. It is the foundation on which all other IP protocols are built. IP is a network-layer protocol that contains addressing and control information that allows data packets to be routed.

This section describes how to configure the Internet Protocol (IP). A number of tasks are associated with configuring IP. A basic and required task for configuring IP is to assign IP addresses to network interfaces. Doing so enables the interfaces and allows communication with hosts on those interfaces using IP. Associated with this task are decisions about subnetting and masking the IP addresses.

5.1 Assign IP Addresses to Network Interfaces

An IP address is a location to and from which IP datagrams can be sent. IP addresses were traditionally divided into three classes. The Class A Internet address format allocated the highest eight bits to the network field and set the highest-order bit to 0 (zero). The remaining 24 bits formed the host field. The Class B Internet address allocated the highest 16 bits to the network field and set the two highest-order bits to 1, 0. The remaining 16 bits formed the host field. The Class C Internet address allocated the highest 24 bits to the network field and set the three highest-order bits to 1,1,0. The remaining eight bits formed the host field.

The table below lists the traditional classes and ranges of IP addresses and their status.

Class	**Address or Range**	**Status**
A	0.0.0.0 1.0.0.0 to 126.0.0.0 127.0.0.0	Reserved Available Reserved
B	128.0.0.0 to 191.254.0.0 191.255.0.0	Available Reserved
C	192.0.0.0 192.0.1.0 to 223.255.254 223.255.255.0	Reserved Available Reserved
D	224.0.0.0 to 239.255.255.255	Multicast group addresses
E	240.0.0.0 to 255.255.255.254 255.255.255.255	Reserved Broadcast

With the rapid expansion of networks being connected to the Internet, critical problems were seen with the traditional classified addressing scheme. It was possible that IP addresses would run out, and routing tables would be overwhelmed. Thus, the Classless Inter-Domain Routing (CIDR) addressing scheme was created.

CIDR replaces the older process of assigning IP addresses with general prefixes of 8, 16, or 24 bits. CIDR uses prefixes of 13 to 27 bits. A CIDR address includes the standard 32-bit IP address and adds information on how many bits are used for the network prefix. In the IP address 206.203.1.35/27, the “/27” indicates that the first 27 bits are used to identify the unique network, and the remaining bits are used to identify the specific host. Now, blocks of addresses can be better fitted to even very small or very large networks.

The following table describes the Class C equivalent of CIDR prefixes.

CIDR Prefix	Class C Equivalent	Host Addresses
/27	1/8 Class C	32 Hosts
/26	1/4 Class C	64 Hosts
/25	1/2 Class C	128 Hosts
/24	1 Class C	256 Hosts
/23	2 Class C	512 Hosts
/22	4 Class C	1,024 Hosts
/21	8 Class C	2,048 Hosts
/20	16 Class C	4,096 Hosts
/19	32 Class C	8,192 Hosts
/18	64 Class C	16,384 Hosts
/17	128 Class C	32,768 Hosts
/16	256 Class C OR 1 Class B	65,536 Hosts
/13	2,048 Class C	524,288 Hosts

An interface can have one primary IP address. To assign a primary IP address and a network mask to a network interface, use the following command, starting in global configuration mode.

Command	Purpose
Interface *interface name*	Enters the interface configuration mode.
ip address *address* l *mask*	Set a primary IP address for an interface.

5.1.1 Assign Multiple IP Addresses to Network Interfaces

The IC35516 software supports multiple IP addresses per interface. You can specify an unlimited number of secondary addresses. Secondary IP addresses can be used in a variety of applications:

There might not be enough host addresses for a particular network segment. *S*uppose your sub-netting allows up to 254 hosts per logical subnet, but you need to have 300 host addresses on one physical subnet. Using secondary IP addresses on the routers or access servers allows you to have two logical subnets using one physical subnet.

Many older networks were built using Level 2 bridges, and were not sub-netted. The use of secondary addresses can aid in the transition to a sub-netted, router-based network. Routers on an older, bridged segment can easily be made aware of multiple subnets are on that segment.

You can create a single network from subnets that are physically separated by another network by using a secondary address. In these instances, the first network is layered on top of the second network. Note that a subnet cannot appear on more than one active interface of the router at a time.

Note: If any router on a network segment uses a secondary address, all other routers on that same segment must also use a secondary address from the same network or subnet.

To assign multiple IP addresses to network interfaces, use the following command in interface configuration mode:

Command	Purpose
ip address *address* l *mask* **secondary**	Assign multiple IP addresses to network interfaces.

5.2 Establish Address Resolution

A device in the IP can have both a local address (which uniquely identifies the device on its local segment or LAN) and a network address (which identifies the network to which the device belongs). The local address is more properly known as a *data link* address because it is contained in the data link layer (Layer 2 of the OSI model) part of the packet header and is read by data link devices (bridges and all device interfaces, for example). The more technically inclined will refer to local addresses as *MAC addresses*, because the Media Access Control (MAC) sub-layer within the data link layer processes addresses for the layer.

To communicate with a device on Ethernet, you first must determine the 48-bit MAC or local data link address of that device. The process of determining the local data link address from an IP address is called *address resolution.* The IC35516 software uses the Address Resolution Protocol (ARP) for address resolution. ARP is used to associate IP addresses with media or MAC addresses. Taking an IP address as input, ARP determines the associated media address.

Once a media or MAC address is determined, the IP address/media address association is stored in an ARP cache for rapid retrieval. Then the IP datagram is encapsulated in a link-layer frame and sent over the network.

5.2.1 Define a Static ARP Cache

ARP provides a dynamic mapping between IP addresses and media addresses. Because most hosts support dynamic address resolution, you generally do not need to specify static ARP cache entries. Completing this task installs a permanent entry in the ARP cache. The entry is used to translate 32-bit IP addresses into 48-bit hardware addresses.

Optionally, you can specify that the software respond to ARP requests as if it was the owner of the specified IP address. You also have the option of specifying an interface when you define ARP entries.

Perform the following task in global configuration mode, to provide static mapping between IP addresses and media addresses.

Command	Purpose
arp *ip-address hardware-address*	Globally associate an IP address with a media (hardware) address in the ARP cache.
arp *ip-address hardware-address* [*interface*]	Specify that the software respond to ARP requests as if it was the owner of the specified interface.

To display the ARP being used on a particular interface, use the **show interface** in top mode or global configuration mode. Use the **show arp** command in top or configuration mode to examine the contents of the ARP cache.

Configuring IP Routing

IP routing protocols are divided into two classes: Interior Gateway Protocols (IGPs) and Exterior Gateway Protocols (EGPs).

Note: The word *gateway* is often a part of a routing protocol's name, since many routing protocol specifications refer to routers as gateways. However, a protocol translation gateway is usually defined by the Open System Interconnection (OSI) reference model as a Layer 7 device, whereas a router is a Layer 3 device, and routing protocol activities occur at the Layer 3 level.

Interior gateway protocols are used to exchange routing information among routers in an autonomous network, such as a company's LAN. A routing protocol determines how routers in a network share and update information and report changes, enabling a network to be dynamic instead of static. All IP interior gateway protocols must be specified with a list of associated networks before routing activities can begin on the switch. The IC35516 supports the Open Shortest Path First (OSPF) and Routing Information Protocol (RIP) as interior gateway protocols.

Exterior protocols are used to exchange routing information between networks that do not share a common administration. The supported exterior gateway protocol is Border Gateway Protocol (BGP).

With any of the IP routing protocols, you must create the routing process, associate networks with the routing process, and customize the routing protocol for a particular network.

5.3 Configuring Static Routes

Static routes are user-defined routes that cause packets that are moving between a source and a destination to take a specified path. Static routes can be important if the switch cannot build a route to a particular destination.

To configure static routes, perform the following task in global configuration mode:

Command	**Purpose**
ip route {*prefix mask* | *prefix-length*} *address* | *interface*} [<*1-255*>]	Establish a static route.

Note: The numeric value is the static administrative distance. Enter a number between 1 and 255. See Table 5-3 for a list of default administrative distances for common routing protocols.

The software retains the configured static routes until they are removed, using the **no ip route** global configuration command. However, you can override the static routes with dynamic routing information through the assignment of administrative distance values. Each dynamic routing protocol has a default administrative distance, as listed in Table 5-3. If you would like a static route to be overridden by information from a dynamic routing protocol, you will need to ensure that the administrative distance of the static route is **higher** than that of the dynamic protocol, since the lower value will be used. For example, if a route is known both by OSPF and RIP, the OSPF route will be used, since its default administrative distance is lower than RIP.

Note: Static routes that point to an interface will not be advertised via RIP, nor by other dynamic routing protocols, unless a **redistribute static** command is specified for these protocols.

When an interface goes down, all static routes through that interface are removed from the IP routing table. Also, when the software can no longer find a valid next hop for the specified forwarding router's address in a static route, the static route is removed from the IP routing table.

Route Source	**Default Distance**

Connected interface	0
Static route	1
External BGP	20
OSPF	110
RIP	120
Internal BGP	200
Unknown	255

Table 5-3: Dynamic Routing Protocol Default Administrative Distances

5.4 Configuring RIP

The Routing Information Protocol (RIP) is a commonly used interior gateway protocol (IGP) created for use in small, homogeneous networks. It is a distance-vector routing protocol, documented in RFC 1058.

RIP uses broadcast User Datagram Protocol (UDP) data packets to exchange routing information. The IC35516 sends, or advertises, routing information updates every 30 seconds. If a router does not receive an update from another router for 180 seconds or more, it will mark the routes served by the non-updating router as being unusable. If there is still no update after another 120 seconds, the router will remove all routing table entries for the non-updating router.

RIP uses the metric *hop count* to rate the value of different routes. The hop count is the number of routers that can be traversed in a route. A directly connected network has a metric of zero; an unreachable network has a metric of 16. This makes RIP an unsuitable routing protocol for large networks with many routers.

A router that is running RIP can receive a default network via an update from another router that is running RIP, or the router can source the default network itself with RIP. In both cases, the default network is advertised to other RIP neighbors. RIP sends updates to the interfaces in the specified networks. If an interface's network is not specified, it will not be advertised in any RIP update. The IC35516 supports RIP Version 2.

5.4.1 Enable RIP

RIP must be enabled before carrying out any other of the RIP commands. To enter router configuration mode for RIP, start in global configuration mode and enter the following command(s):

```
Router(config)# router rip
Router(config-rip-router)#
```

The **network** command enables RIP interfaces between certain numbers of a special network address. For example, if the network for 10.0.0.0/24 is RIP enabled, this would result in all the addresses from 10.0.0.0 to 10.0.0.255 being enabled for RIP.

Command	Purpose
router rip	Enable a RIP routing process, which places you in router configuration mode.

network {*IP prefix*}	Associate a network with a RIP routing process.

5.4.2 Allow Unicast Updates for RIP

Because RIP is normally a broadcast protocol, in order for RIP routing updates to reach non-broadcast networks, it is necessary to establish a direct link between routers. Use the following command in router configuration mode.

Command	Purpose
neighbor *ip-address*	Define a neighboring router with which to exchange routing information.

To control the set of interfaces with which you want to exchange routing updates, you can disable the sending of routing updates on specified interfaces by configuring the **passive-interface** command.

5.4.3 Specify a RIP Version

By default, the software receives RIP Version 1 and Version 2 packets, but sends only Version 1 packets. You can configure the software to receive and send only Version 1 packets or only Version 2 packets. To do so, perform the following task in router configuration mode.

Command	Purpose
version {**1** | **2**}	Configure the software to receive and send only RIP Version 1 or only RIP Version 2 packets.

You can override the router's RIP version by configuring a particular interface to behave differently. To control which RIP version an interface sends, perform one of the following tasks in interface configuration mode.

Command	Purpose
ip rip send version 1	Configure an interface to send only RIP Version 1 packets.
ip rip send version 2	Configure an interface to send only RIP Version 2 packets.
ip rip send version 1 2	Configure an interface to send only RIP Version 1 and Version 2 packets.

Similarly, to control how packets received from an interface are processed, perform one of the following tasks in interface configuration mode.

Command	Purpose
ip rip receive version 1	Configure an interface to accept only RIP Version 1 packets.
ip rip receive version 2	Configure an interface to accept only RIP Version 2 packets.
ip rip receive version 1 2	Configure an interface to accept only RIP Version 1 and Version 2 packets.

5.4.4 Redistribute Routing Information

The router can redistribute routing information from a source route entry into the RIP tables. For example, you can instruct the router to re-advertise connected, kernel, or static routes as well as routing protocol-derived routes. This capability applies to all the IP-based routing protocols.

To redistribute routing information from a source route entry into the RIP table, perform the following task in router configuration mode.

Command	Purpose
Redistribute {**connected** | **kernel** | **static** | **ospf** | **bgp | rip**} **metric** *value* | **route-map** *map-tag*]	Advertise routing information into the RIP tables.

You may also conditionally control the redistribution of routes between the two domains using **route-map** command from global configuration mode.

Use route maps for finer control over how routes are advertised throughout the network. Use the **route-map** command in conjunction with the match and set commands to define the conditions for redistributing routes from one routing protocol to another and within the same routing protocol.

Command	Purpose
route-map *map-tag* {**deny** | **permit**} *sequence-number*	Create a route-map.

You can define multiple route maps with the same map-name. Maps with the same map-name are differentiated by a sequence-number. If a route passing through a route map controlling redistribution does not meet any of the match criteria, the route is passed through the next instance of the route map with the same map-name and next higher sequence number. Route processing continues until a match is made or the route is processed by all instances of the route map with no match. If the route is processed by all instances of a route map with no match, the route is not accepted (inbound route maps) or forwarded (outbound route maps).

```
Router(config)# route-map map-tag permit 10
Router(config-route-map)# ?
  end         End current mode and change to enable mode
  exit        Exit current mode and down to previous mode
  help        Description of the interactive help system
  match       Match values from routing table
  no          Negate a command or set its defaults
  on-match    Exit policy on matches
  quit        Exit current mode and down to previous mode
  route-map   Create route-map or enter route-map command mode
  set         Set values in destination routing protocol
Router(config-route-map)#
```

One or more **match** and **set** commands typically follow a **route-map** command. If there are no **match** commands, then everything matches. If there are no **set** commands, nothing is done. Therefore, you need at least one match or set command. You can enter match commands into a route map in any order. If the match criteria are met, and permit is on, then the route is redistributed or controlled as defined by the set commands and route-map processing is complete. If the match criteria are met, and deny is on, then the route is not redistributed or controlled and route-map processing is complete.

To define conditions for redistributing routes from a source route entry into the RIP tables, perform at least one of the following tasks in route-map configuration mode:

Command	Purpose
match interface *interface-name*	Match the specified interface.
match ip address {*access-list-name* | **prefix-list** *prefix-list-name*}	Match a standard access list or prefix list.
match ip next-hop *access-list-name*	Match a next-hop router address passed by one of the access lists specified.
match metric *metric-value*	Match the specified metric.
set ip next-hop *ip-address*	Specify the address of the next hop.
set metric *metric-value*	Set the metric value to give the redistributed routes.

5.4.5 Set Metrics for Redistributed Routes

The metrics of one routing protocol do not necessarily translate into the metrics of another. For example, the RIP metric is a hop count and the OSPF metric is a combination of five quantities.

In such situations, an artificial metric is assigned to the redistributed route. Because of this unavoidable tampering with dynamic information, carelessly exchanging routing information between different routing protocols can create routing loops, which can seriously degrade network operation.

To use the current routing protocol's metric value for all redistributed routes, enter the following command in router configuration mode.

Command	Purpose
default-metric *metric-value*	Cause the current routing protocol to use the same metric value for all redistributed routes.

Note: The metric value range is very large for compatibility with other protocols (0-2494967295).

For RIP, valid metric value is from 1 to 16.

5.4.6 Set Administrative Distance

The administrative distance is a value that rates the trustworthiness of a routing information source, such as an individual router or a group of routers. In a large network, some routing protocols and some routers can be more reliable than others as sources of routing information. Also, when multiple routing processes are running in the same router for IP, it is possible for the same route to be advertised by more than one routing process. By specifying administrative distance values, you enable the router to intelligently discriminate between sources of routing information.

The router will always pick the route whose routing protocol has the lowest administrative distance. There are no general guidelines for assigning administrative distances, because each network has its own requirements. You must determine a reasonable matrix of administrative distances for the network as a whole.

To set an administrative RIP distance to a specified value, use the **distance** router configuration command.

Command	Purpose
distance *distance-value* [*prefix*] [*access-list-name*]	Assign an administrative distance.

5.4.7 Generate a Default Route

You can force an autonomous system boundary router to generate a default route into an RIP routing domain. Whenever you specifically configure the redistribution of routes into an RIP routing domain, the router automatically becomes an autonomous system boundary router. However, an autonomous system boundary router does not, by default, generate a *default route* into the RIP routing domain.

To force the autonomous system boundary router to generate a default route, perform the following task in router configuration mode:

Command	Purpose
default-information originate	Forces the autonomous system boundary router to generate a default route into the RIP routing domain.

5.4.8 Filtering Routing Information

The following tasks let you filter routing protocol information:

- Suppress the sending of routing updates on a particular router interface in order to prevent other systems on an interface from dynamically learning about routes
- Suppress networks from being advertised in routing updates in order to prevent other routers from learning a particular device's interpretation of one or more routes
- Apply an offset to routing metrics in order to provide a local mechanism for increasing the value of routing metrics

Suppress Routing Updates through an Interface

To prevent other routers on a local network from dynamically learning about routes, you can keep routing update messages from being sent through a router interface. This feature applies to all IP-based routing protocols except BGP.

Command	Purpose
passive-interface *interface-name*	Suppress the sending of routing updates through a router interface.

Suppress the Advertising of Route Updates

In order to filter routing information, you can suppress the networks listed in updates from being advertised and processed by a routing process. If you apply access-lists or prefix-lists to a chosen interface, the routing path in an update is filtered on the lists.

To do this, perform the following task in router configuration mode.

Command	Purpose
distribute-list {*access-list-name* | **prefix** *prefix-list-name*} **in** | **out**} [*interface-name*]	Suppress routes from being advertised and processed in routing updates depending upon the action listed in the access list or prefix list.

Apply Offsets to Routing Metrics

An offset list is the mechanism for increasing incoming and outgoing metrics to routes learned via RIP. You can limit the offset list with an access list. To increase the value of routing metrics, perform the following task in router configuration mode.

Command	Purpose
offset-list *access-list-name* { **in** | **out**}	Apply an offset to routing metrics.

5.4.9 Adjust Timers

Routing protocols use several timers that determine such variables as the frequency of routing updates, the length of time before a route becomes invalid, and other parameters. These timers can be adjusted to fine-tune the routing protocol performance to better suit the inter-network needs.

The default settings for the various timers are as follows:

- The *update* timer is 30 seconds. During every update, the RIP process sends an unsolicited response message containing the complete routing table to all neighboring RIP routers
- The *timeout* timer is 180 seconds. Upon expiration of the timeout, an unresponsive route becomes invalid; however, it is retained in the routing table for a short time so that neighbors can be notified that the route has been dropped
- The *garbage collect* timer is 120 seconds. Upon expiration of the garbage-collection timer, the unresponsive route is finally removed from the routing table

To adjust the timers, use the following command in router configuration mode.

Command	Purpose
timers basic *update timeout garbage*	Adjust routing protocol timers.

5.4.10 Enable or Disable Split-horizon

Normally, routers that are connected to broadcast-type IP networks, and that use distance-vector routing protocols, employ *split horizon with poison reverse* to reduce the possibility of routing loops.

The *split horizon with poison reverse* mechanism blocks information about routes from being advertised by a router out any interface from which that information originated. This behavior usually optimizes communications among multiple routers, particularly when links are broken. However, with non-broadcast networks, such as Frame Relay, situations can arise for which this behavior is less than ideal. For these situations, a user might want to disable split horizon. If an interface is configured with secondary IP addresses and split horizon is enabled, updates might not be sourced by every secondary address. Only one routing update is sourced per network number, unless split horizon is disabled.

To enable or disable split horizon, perform the following tasks in interface configuration mode.

Command	Purpose
ip rip poison reverse	Enable split horizon with poison reverse.
no ip rip poison reverse	Disable split horizon with poison reverse.

5.4.11 Manage Authentication Keys

If you are sending and receiving RIP Version 2 packets, you can enable RIP authentication on an interface. RIP Version 1 does not support authentication.

The IC35516 software supports two modes of authentication on an interface for which RIP authentication is enabled: plain text authentication and MD5 authentication. The default authentication in every RIP Version 2 packet is plain text authentication.

Important! Do not use plain text authentication in RIP packets for security purposes because the unencrypted authentication key is sent in every RIP Version 2 packet. Use plain text authentication when security is not an issue (for example, to ensure that incorrectly configured hosts do not participate in routing).

Command	Purpose
ip rip authentication mode {**text** | **md5**}	Configure the interface to use MD5 digest authentication or let it default to simple password authentication.
ip rip authentication string *string*	Set the interface with plain text authentication. The string must be shorter than 16 characters.

5.4.12 Monitor and Maintain RIP

You can display specific router statistics, such as the contents of IP routing tables and databases, in order to monitor and maintain RIP. Information provided can be used to determine resource utilization and solve network problems. It is also possible to discover the routing path that the packets are taking through the network.

To display various router statistics, perform the following tasks in top mode.

Command	Purpose
show ip rip	Display general information about RIP routing processes in a particular router.
show ip protocols	Display the parameters and current state of the active routing protocol process.

The debugging commands are helpful to quickly diagnose problems. Use the following commands in privileged top configuration mode to display information on RIP routing transactions.

Command	Purpose
debug ip rip events	Display RIP events, including sending and receiving packets and changes in interfaces.

debug ip rip packet [**recv** | **send**] **detail**	Display detailed information about the RIP packets. The information includes the origin and port number of the packet as well as a packet dump.
show debugging rip	Show all information currently set for RIP debug.

5.5 Configuring IP Multicast Routing

Multicast traffic is a means to transmit a multimedia stream from the Internet (a video conference, for example) without requiring a TCP connection from every remote host that wants to receive the stream.

Traditional IP communication allows a host to send packets to one host (unicast transmission) or to all hosts (broadcast transmission). IP multicast provides a third scheme, allowing a host to send packets to a group of hosts (group transmission). A multicast address is chosen for the members of a multicast group. Senders use that address as the destination address of a datagram to reach all hosts of the group. The stream is sent to the multicast address, and from there it's delivered to all interested parties on the Internet. Any host, regardless of whether it is a member of a group, can send to that group. However, only the members of the group receive the message.

The IC35516 supports the following protocols to implement IP multicast routing:

- **Internet Group Management Protocol (IGMP)**: used between hosts on a LAN and the router(s) on that LAN to track the multicast groups of which hosts are members
- **Distance Vector Multicast Routing Protocol (DVMRP)**: used on the MBONE (the multicast backbone of the Internet)

5.5.1 IGMP

The Internet Group Management Protocol (IGMP) manages the multicast groups on a LAN. IP hosts use IGMP to report their group membership to directly connected multicast routers. Routers executing a multicast routing protocol maintain forwarding tables to forward multicast datagrams. Routers use the IGMP to learn whether members of a group are present on their directly attached sub-nets. Hosts join multicast groups by sending IGMP report messages.

IGMP uses group addresses, which are Class D IP addresses. The high-order four bits of a Class D address are 1110. Therefore, host group addresses can be in the range 224.0.0.0 to 239.255.255.255.

The address 224.0.0.0 will not be assigned to any group. The address 224.0.0.1 is assigned to all systems on a sub-net. The address 224.0.0.2 is assigned to all routers on a sub-net.

5.5.2 Configuring IGMP

Use the following commands to configure IGMP.

Modifying the IGMP Host-Query Message Interval

Multicast routers send IGMP host-query messages to discover which multicast groups are present on attached networks. These messages are sent to the all-systems group address of 224.0.0.1 with a time-to-live (TTL) value of 1.

Multicast routers continue to periodically send host-query messages to refresh their knowledge of memberships present on their networks. If, after some number of queries, the router software discovers that no local hosts are members of a multicast group, the software stops forwarding onto the local network multicast packets from remote origins for that group and sends a prune message upstream toward the source.

Multicast routers elect designated router (DR) for the LAN (subnet). The DR is the router with the highest IP address. The DR is responsible for sending IGMP host-query messages to all hosts on the LAN. By default, the DR sends IGMP host-query messages every 60 seconds in order to keep the IGMP overhead on hosts and networks very low. To modify this interval, use the following command in interface configuration mode:

Command	Purpose
ip igmp query-interval *<1-65535 seconds>*	Configure the frequency at which the designated router sends IGMP host-query messages.

```
Router(config-if-veth1)# ip igmp query-interval 200
```

Changing the IGMP Version

By default, the router uses IGMP Version 2, which allows such features as the IGMP query timeout and the maximum query response time.

All systems on the subnet must support the same version. The router does not automatically detect Version 1 systems and switch to Version 1. Configure the router for Version 1 if your hosts do not support Version 2.

To control which version of IGMP the router uses, use the following command in interface configuration mode:

Command	Purpose
ip igmp version {**2** | **1**}	Select the IGMP version that the router uses.

Changing the Maximum Query Response Time

By default, the maximum query response time advertised in IGMP queries is 10 seconds. If the router is using IGMP Version 2, you can change this value. The maximum query response time allows a router to quickly detect that there are no more directly connected group members on a LAN. Decreasing the value allows the router to prune groups faster.

To change the maximum query response time, use the following command in interface configuration mode:

Command	Purpose
ip igmp query-max-response-time *<1-25 seconds>*	Set the maximum query response time advertised in IGMP queries.

Configuring the Router as a Statically Connected Member

To configure the router itself to be a statically connected group member, use the following command in interface configuration mode:

Command	Purpose
ip igmp static-group *A.B.C.D*	Configure the router as a statically connected member of a group.

Configuring the TTL Threshold

The time-to-live (TTL) value controls whether packets are forwarded out of an interface. The TTL value is specified in hops. Only multicast packets with a TTL value greater than the interface TTL threshold are forwarded on the interface. The default value is 0, which means that all multicast packets are forwarded on the interface.

To change the default TTL threshold value, use the following command in interface configuration mode:

Command	Purpose
ip multicast ttl-threshold *<0-255>*	Configure the TTL threshold of packets being forwarded out an interface.

5.5.3 DVMRP

Distance Vector Multicast Routing Protocol (DVMRP) is a routing protocol that provides packet delivery to a group of hosts across an inter-network. DVMRP routers dynamically discover their neighbors by sending neighbor probe messages periodically to an IP multicast group address that is reserved for all DVMRP routers. These mechanisms allow the formation of shortest-path trees, which are used to forward packets to all group members from each network source of multicast traffic. Multicast packets are initially flooded down a source tree. If redundant paths are on the source tree, packets are not forwarded along those paths. Forwarding occurs until Prune messages are received on those links, which further constrain the broadcast of multicast packets.

DVMRP is designed as an interior gateway protocol (IGP) within a multicast domain.

5.5.4 Configuring DVMRP

This section presents the commands for configuring DVMRP IP Multicast Routing Protocol. The following commands are available from global configuration mode:

```
Router(config)# ip dvmrp ?
  enable                      Enable DVMRP Multicast Routing Protocol
  graft-retransmit-interval   DVMRP graft message retransmitting interval
  nbr-timeout                 DVMRP neighbor timeout value
  probe-interval              DVMRP Neighbor Probe message interval
  prune-age                   DVMRP prune lifetime value in seconds
  report-interval             DVMRP report interval
  route-discard-timeout       DVMRP route discard timeout
  route-expire-timeout        DVMRP route expiration timeout
  route-holddown-time         DVMRP route holdown time
Router(config)# ip dvmrp
```

Important! Remember that a **no** command (such as **no ip dvmrp enable**) negates a previously entered command.

Enabling DVMRP

In order to enable DVMRP protocol, you must enter into the global configuration mode and then issue the following global command.

Command	Purpose
ip dvmrp enable	Enable a DVMRP IP Multicast routing process, which places you in router configuration mode.

Graft-retransmit-interval

This value defines the interval of time that a DVMRP router sending a graft message will wait for a graft acknowledgment from an upstream router before re-transmitting that message.

Subsequent re-transmissions will be sent at an interval of twice that of the preceding interval.

DVMRP must be enabled on the router for this command to be operational.

Command	Purpose
graft-retransmit-interval <*5–3600 seconds*>	Defines the initial period of time that a DVMRP router sending a graft message will wait for acknowledgement. **Default value:** 10 seconds

Nbr-timeout

This value sets the neighbor timeout value, which is the period of time that a router will wait before it defines an attached DVMRP neighbor router as down.

DVMRP must be enabled on the router for this command to be operational.

Command	Purpose
nbr-timeout <*35–8000 seconds*>	Sets neighbor timeout value. **Default value:** 40 seconds

Probe-interval

This value defines how often neighbor probe messages are sent to the ALL-DVMRP-ROUTERS IP multicast group address.

A router's probe message lists those neighbor DVMRP routers from which it has received probes.

DVMRP must be enabled on the router for this command to be operational.

Command	Purpose
probe-interval <5–30 seconds>	Defines how often neighbor probe messages are sent to the ALL-DVMRP-ROUTERS IP multicast group address. **Default value:** 10 seconds

Prune-age

This value defines how long a prune state will remain in effect for a source-routed multicast tree. After the prune age period expires, flooding will resume.

DVMRP must be enabled on the router for this command to be operational.

Command	Purpose
prune-age *<20–8000 seconds>*	Defines how long a prune state will remain in effect for a source-routed multicast tree. After the prune age period expires, flooding will resume. **Default value:** 180 seconds

Report-interval

This value defines how often routers will propagate their complete routing tables to other neighbor DVMRP routers.

DVMRP must be enabled on the router for this command to be operational.

Command	Purpose
report-interval *<10–2000 seconds>*	Defines how often routers will propagate their complete routing tables to other neighbor DVMRP routers. **Default value:** 60 seconds

Route-discard-timeout

This value defines the period of time before a route is deleted on a DVMRP router.

DVMRP must be enabled on the router for this command to be operational.

Command	Purpose
route-discard-timeout *<40–8000seconds>*	Defines the period of time before a route is deleted on a DVMRP router. **Default value:** 340 seconds

Route-expire-timeout

This value defines how long a route is considered valid without the next route update.

DVMRP must be enabled on the router for this command to be operational.

Command	Purpose
route-expire-time *<20–4000 seconds>*	Defines how long a route is considered valid without the next route update. **Default value:** 200 seconds

5.6 Using Access Lists

An access list is a collection of criteria statements that the switch uses to determine whether to allow or block traffic based on IP addresses. Access lists can be configured to provide basic security on your network, and to prevent unnecessary traffic between network segments.

When configuring an access list, you can add multiple statements by adding criteria to the same numbered list. The order of the statements is important, as the switch tests addresses against the criteria in an access list one by one (in the order the statements are entered) until it finds a match. The first match determines whether the software accepts or rejects the address. Because the software stops testing conditions after the first match, the order of the conditions is critical.

Important! You may not delete an individual statement from an access list; you must delete the entire access list and re-enter it with new statements.

Important! By default, if no conditions match, the software rejects the address.

The switch supports two types of access lists:

- **Standard**: access list numbers 1–99 and 1300–1999 (expanded range)
- **Extended**: access list numbers 100–199 and 200–2699 (expanded range)

5.6.1 Create a Standard Access List

Standard access lists filter at Layer 3, and can allow or block access to networks and host addresses. The parameters for a standard access list are described as follows:

- **Access list number (1–99)**: Identifies the access list to which an entry belongs. There is no limit to how many entries make up an access list, other than available memory
- **Remark**: Access list entry comment. This may be useful to keep track of numbered lists
- **Permit/deny**: Indicates whether this entry allows or blocks traffic from the specified source address
- **Source address**: Enter the source IP address to match
- **Any**: Specifies any source address to match
- **Source wildcard mask**: Identifies which bits in the address field are to be matched. A “0” indicates that positions must match; a “1” indicates that position is ignored

In the following example, a standard access list will be created to allow all traffic from the 192.168.0.0 networks, while blocking all non-192.168.0.0 traffic. The last entry is redundant, since the switch will deny access if there is no match found by the end of the list.

```
Router# configure terminal
Router(config)# access-list 1 ?
  deny    Specify packets to reject
  permit  Specify packets to forward
  remark  Access list entry comment
Router(config)# access-list 1 permit ?
  A.B.C.D  Source address to match. e.g. 10.0.0.0
  any      Any source address to match
Router(config)# access-list 1 permit 192.168.0.0 ?
  A.B.C.D  Source wildcard. e.g. 0.0.0.255
  <cr>
Router(config)# access-list 1 permit 192.168.0.0 0.0.255.255
Router(config)# access-list 1 deny any {0.0.0.0 255.255.255.255}
```

In the next example, a standard access list will be created to deny all traffic from 192.168.123.254 and allow all other traffic to be forwarded. Note that the last entry of this example is not redundant, as it is a *permit* statement. An implicit

deny statement would follow the last entry, if no match was found before the end of the list. In this case, however, we are permitting any other IP address other than 192.168.123.254, and a *deny* statement isn't necessary.

```
Router(config)# access-list 1 deny 192.168.123.254 ?
  A.B.C.D  Source wildcard. e.g. 0.0.0.255
  <cr>
Router(config)# access-list 1 deny 192.168.123.254
Router(config)# access-list 1 permit any {0.0.0.0 255.255.255.255}
Router(config)# exit
Router# show access-list
```

After entering the access list, use the **show** command from privileged mode, as shown above. Any lists you've created, as well as any remark entered for a list, will be displayed.

Note: In the above examples, the argument *any* can be used instead of 0.0.0.0 255.255.255.255.

5.6.2 Create an Expanded Access List

Extended access lists filter at Layer 4, and can check source and destination addresses as well as filter transport layer information, such as TCP and UDP protocols. In addition to the standard access list parameters listed above, an extended access list also uses the following information:

- **Access list number (100–199)**: Identifies the access list to which an entry belongs
- **IP/ICMP/TCP/UDP**: Specifies protocol connection
- **Destination address**: Specifies the destination address to match
- **Operator operand**: Select **eq** (equal to), **gt** (greater than), **lt** (less than), or **neq** (not equal to) to specify how to match the protocol port number
- **0-65535**: Specifies the protocol port number. Well-known ports are listed below:

20	File Transfer Protocol (FTP) data
21	FTP Program
23	Telnet
25	Simple Mail Transfer Protocol (SMTP)
69	Trivial File Transfer Protocol (TFTP)
53	Domain Name System (DNS)
80	Hypertext Transport Protocol (HTTP)
110	Post Office Protocol (POP3)
119	Network News Transport Protocol (NNTP)

In the following example, an extended access list will be created to deny FTP and allow all other traffic from subnet 192.168.123.0 to be forwarded to all other networks or subnets.

Note: Remember when the cursor reaches the right margin, the command line shifts 8 spaces to the left. You cannot see the first eight characters of the line, but you can scroll back and check the syntax at the beginning of the command, using **Ctrl-B** or the left arrow keys.

```
Router# configure terminal
Router(config)# access-list 101 ?
  remark  Access list entry comment
  deny    Specify packets to reject
  permit  Specify packets to forward
Router(config)# access-list 101 deny ?
  ip    Specify IP connections
```

```
  icmp  Specify ICMP connections
  tcp   Specify TCP connections
  udp   Specify UDP connections
Router(config)# access-list 101 deny tcp ?
  A.B.C.D  Source address to match. e.g. 10.0.0.0
  host     Host address to match.
  any      Any source address to match
Router(config)# access-list 101 deny tcp 192.168.123.0 0.0.0.255 ?
  A.B.C.D  Destination address to match. e.g. 10.0.0.0
  host     Host address to match.
  any      Any destination address to match
Router(config)# $ist 101 deny tcp 192.168.123.0 0.0.0.255 192.168.124.0 ?
  eq    Operator - equal to
  gt    Operator - greater then
  lt    Operator - less then
  neq   Operator - NOT equal to
  <cr>
Router(config)# $ list 101 deny tcp 192.168.123.0 0.0.0.255 192.168.124.0 eq ?
  <0-65535>  Protocol port number
Router(config)# $ eny tcp 192.168.123.0 0.0.0.255 192.168.124.0 0.0.0.255 eq 21
Router(config)# $ eny tcp 192.168.123.0 0.0.0.255 192.168.124.0 0.0.0.255 eq 20
Router(config)# $ permit ip 192.168.123.0 0.0.0.255 0.0.0.0 255.255.255.255
Router(config)# exit
Router# show access-list
```

5.6.3 Creating an Access List with a Name

From the global configuration mode, you can also create access lists through the `Router(config)# ip` command. Through this method, you may name your access list, rather than using a number. The new prompt reflects the named access list mode.

```
Router(config)# ip ?
  access-list       Named access-list
  forward-protocol  Controls forwarding of physical and directed IP
  prefix-list       Build a prefix list
  route             Establish static routes
Router(config)# ip access-list ?
  standard  Standard Access List
  extended  Extended Access List
Router(config)# ip access-list standard ?
  WORD  Access-list name or Standard IP access-list number <1-99>
Router(config)# ip access-list standard test
Router(config-std-nacl)# ?
  deny    Specify packets to reject
  end     End current mode and change to enable mode
  exit    Exit current mode and down to previous mode
  help    Description of the interactive help system
  no      Negate a command or set its defaults
  permit  Specify packets to forward
  quit    Exit current mode and down to previous mode
  remark  Access list entry comment
Router(config-std-nacl)#
```

At the `Router(config-std-nacl)#` prompt, you may proceed with the access list permit or deny statements.

5.6.4 Applying an Access List to an Interface

After creating your access lists, you must apply them to an interface in order to enable the access list. Enter the interface configuration mode for the desired interface. Each interface may have only one access list applied to it at one time. Access lists are applied to either inbound traffic or to outbound traffic.

In the next example, we will create an extended access list that will allow only SMTP traffic (port 25) to be sent out, and deny all other traffic.

```
Router(config)# access-list 101 permit tcp 192.168.123.0 0.0.0.255 any eq 25
Router(config)# access-list 101 deny any
Router(config)# interface eth1
Router(config-if-eth1)# ip ?
  access-group  Apply an access-group entry
Router(config-if-eth1)# ip access-group ?
  WORD  access-list number or name
Router(config-if-eth1)# ip access-group 101 ?
  in   inbound direction
  out  outbound direction
Router(config-if-eth1)# ip access-group 101 out
Router(config-if-eth1)# exit
```

5.7 Configuring OSPF

Open Shortest Path First (OSPF) is an interior gateway protocol (IGP) designed expressly for IP networks. OSPF supports IP sub-netting and tagging of externally derived routing information, as well as supporting packet authentication and IP multicasting when sending/receiving packets.

OSPF works best in a hierarchical routing environment. The first and most important decision on OSPF network is to determine area border routers (routers connected to multiple areas), and autonomous system boundary routers. At a minimum, OSPF-based routers can be configured with all the default parameter values, no authentication, and interfaces assigned to areas. If users intend to customize their networking environment, they must ensure coordinated configurations of all routers.

To configure OSPF, complete the tasks in the following sections. After enabling OSPF, the other configuration tasks are optional.

5.7.1 Enable OSPF

As with other routing protocols, enabling OSPF requires that you create an OSPF routing process, specify the range of IP addresses to be associated with the routing process, and assign area IDs to be associated with that range of IP addresses. Perform the following tasks, starting in global configuration mode.

Command	Purpose
router ospf	**Step 1** Enable an OSPF routing process, which places you in router configuration mode.
router-id *router-id*	**Step 2** Specify a routing process ID. A router ID is a 32-bit number in dotted-decimal notation.
network *prefix-length* **area** {*area-ID* | *area-address*}	**Step 3** Define an interface on which to run OSPF and specify the area ID or IP address for that interface.

5.7.2 Configure ABR Type

The IC35516 OSPF conforms to the specifications in standard RFC2328. Because a variety of implementations support OSPF, the OSPF configuration depends on different types of routers. To configure OSPF on an Area Border Router (ABR), specify what type the router belongs to.

Command	Purpose
abr-type {cisco | ibm | shortcut | standard}	Specify a router (ABR) type.

5.7.3 Configure Compatibility

Compatibility configuration enables the router to be compatible with a variety of RFCs that deal with OSPF. Perform the following task to support many different features within the OSPF protocol.

Command	Purpose
compatible rfc1583compatibility	Enable the router to be compatible with the specifications in RFC 1583.

5.7.4 Configure OSPF Interface Parameters

You can alter certain interface-specific OSPF parameters as needed. While you are not required to alter any of these parameters, some interface parameters must be consistent across all routers in an attached network. Those parameters are controlled by the **ip ospf hello-interval**, **ip ospf dead-interval**, and **ip ospf authentication-key** commands. Therefore, be sure that if you have configured any of these parameters, the configurations for all routers on your network have compatible values.

In interface configuration mode, specify any of the following interface parameters as needed for the network.

Command	Purpose
ip ospf cost *cost*	Specify the cost of sending a packet on an OSPF interface. This cost value is set to the metric field of the Link State Advertisement (LSA) and used for OSPF calculation.
ip ospf retransmit-interval *seconds*	Specify the number of seconds between link state advertisement retransmissions for adjacencies belonging to an OSPF interface. The default value is 5 seconds.
ip ospf transmit-delay *seconds*	Set the estimated number of seconds it takes to transmit a link state update packet on an OSPF interface. LSA's age should be incremented by this value when transmitting. The default value is 1 second.
ip ospf priority *number*	Set priority to help determine the OSPF designated router for a network. By setting a higher value, router will be more likely to become designated router. The default value is 1.
ip ospf hello-interval *seconds*	Specify the length of time, in seconds, between the hello packets that are sent on an OSPF interface. This value must be the same for all routers attached to a common network. The default value is 10 seconds.

ip ospf dead-interval *seconds*	Set the number of seconds that a device's hello packets must not have been seen before its neighbors declare the OSPF router down. This value must be the same for all routers attached to a common network. The default value is 40 seconds.
ip ospf authentication-key *key*	Assign a specific password to be used by neighboring OSPF routers on a network segment that is using OSPF's simple password authentication. The key length can be up to 8 characters.
ip ospf message-digest -key *keyed* **md5** *key*	Set an OSPF MD5 authentication key for cryptographic password. The key length is up to 16 characters.

5.7.5 Configure OSPF Network Type

You have the choice of configuring the OSPF network type as either broadcast or non-broadcast, regardless of the default media type. They can configure broadcast networks as non-broadcast networks when, for example, there are routers in the network that do not support multicast addressing. You can also configure the OSPF network type as a point-to-multipoint network when there is a partially meshed network. Routing between two routers not directly connected will go through the router that has virtual circuits to both routers. This feature saves you from having to configure neighbors.

If an OSPF point-to-multipoint interface is not defined in non-broadcast networks, you must configure neighbors on OSPF network.

To configure the OSPF network type, use the following command in interface configuration mode.

Command	**Purpose**
ip ospf network {broadcast | non-broadcast | point-to-multipoint | point-to-point}	Configure the OSPF network type for a specified interface.

5.7.6 Configure OSPF for Non-broadcast Networks

To configure routers that interconnect to non-broadcast networks, perform the following task in router configuration mode.

Command	**Purpose**
neighbor *ip-address* [**priority** *number*] [**poll-interval** *seconds*]	Configure routers interconnecting to non-broadcast networks.

As there might be many routers attached to an OSPF network, a designated router is selected for the network. It is necessary to use priority and poll-interval parameters in the designated router selection if broadcast capability is not configured. These parameters need only be configured in those devices that are eligible to become the designated router or backup designated router.

5.7.7 Configure Area Parameters

You can configure several area parameters including authentication, defining stub areas, and assigning specific costs to the default route.

Authentication allows password-based protection against unauthorized access to an area. Stub areas are areas into which information on external routes is not sent. Instead, there is a default external route (generated by the area border router) into the stub area for destinations outside the autonomous system. To further reduce the number of link state advertisements sent into a stub area, **no-summary** configuration on the ABR is allowed to prevent it from sending summary link advertisement into the stub area.

In router configuration mode, specify any of the following area parameters as needed for the network.

Command	Purpose
area {*area-id* | *area-address*} **authentication**	Enable authentication for an OSPF area.
area {*area-id* | *area-address*} **authentication message-digest**	Enable MD5 authentication for an OSPF area.
area {*area-id* | *area-address*} **stub** [**no-summary**]	Define an area as a stub area.
area {*area-id* | *area-address*} **default-cost** *cost*	Assign a specific cost to the default summary route used for the stub area.
area {*area-id* | *area-address*} **export-list** *access-list*	Define an area to be advertised into the other areas.
area {*area-id* | *area-address*} **import-list** *access-list*	Define an area to be allowed in the specified area.
area {*area-id* | *area-address*} **shortcut** {*default* | *disable* |*enable*}	Set shortcutting behavior through an area.

5.7.8 Configure OSPF Not So Stubby Area (NSSA)

The NSSA is similar to OSPF stub area. NSSA does not flood Type 5 external link state advertisements (LSAs) from the core into the area, but it has the ability of importing AS external routes in a limited fashion within the area.

The OSPF Specification (RFC 1583) prohibits the summarizing or filtering of Type 5 LSAs. It is an OSPF requirement that Type 5 LSAs always be flooding throughout a routing domain. NSSA allows importing specific external routes as Type 7 LSAs into the NSSA. In addition, when translating Type 7 LSAs into Type 5 LSAs by NSSA ABR, summarization and filtering are supported during the translation.

Use NSSA to simplify administration if you are an Internet Service Provider (ISP) or a network administrator that must connect a central site using OSPF to a remote site that is using a different routing protocol such as RIP.

Prior to NSSA, the connection between the corporate site border router and the remote router could not be run as OSPF stub area because routes for the remote site cannot be redistributed into stub area. With NSSA, you can extend OSPF to cover the remote connection by defining the area between the corporate router and the remote router as an NSSA.

In router configuration mode, specify the following area parameters as needed to configure OSPF NSSA.

Command	Purpose
area *area-id* **nssa [no-summary| translate-always | translate-candidate | translate-never]**	Set an area to be an NSSA.

If you configure an NSSA totally stub area using **no summary** command, inter-area routes are not allowed in the NSSA area. When redistribution takes place in the situations where there is no need to inject external routes into the NSSA, you can prevent the router from creating Type 7 LSAs for NSSA using the **translate-never** command. This situation can occur when an Autonomous System Boundary Router (ASBR) is also an NSSA ABR. On the other hand, the **translate-always** command enables the router to redistribute all external routes as Type 7 LSAs, which are translated into Type 5 LSAs by the NSSA ABR and then leaked into the OSPF domain.

5.7.9 Configure Route Summarization between OSPF Areas

Route summarization causes a single summary route to be advertised to other areas by an ABR.

In OSPF, an ABR will advertise networks in one area into another area. If the network numbers in an area are assigned in a way such that they are contiguous, you can configure the ABR to advertise a summary route that covers all the individual networks within the area that fall into the specified range.

To define an address range, perform the following task in router configuration mode.

Command	**Purpose**
area {*area-id* | *area-address*} **range** *prefix-length* [**not-advertised**]	Define an address range where a single route will be advertised.
area *area-address* **range** *prefix* **{suppress** | **substitute}** *prefix*	Announce an address range where a route will not be injected.

5.7.10 Create Virtual Links

In OSPF, all areas must be connected to a backbone area. If there is a break in backbone continuity, or the backbone is purposefully portioned, you can establish a virtual link. The virtual link must be configured in both routers. The configuration information in each router consists of the other virtual endpoint, and the non-backbone area that the two routers have in common (called the transit area). Note that virtual link cannot be configured through stub areas.

To create a virtual link, perform the following task in router configuration mode.

Command	**Purpose**
area *area-id* **virtual-link** *router-id* [**hello-interval** *seconds*] [**retransmit-interval** *seconds*] [**transmit-delay** *seconds*] [**dead-interval** *seconds*] [[**authentication-key** *key*] | [**message-digest-key** *keyed* **md5** key]]	Establish a virtual link.

5.7.11 Control Default Metrics

OSPF calculates the OSPF metric for an interface according to the bandwidth of the interface. For example, a 64K link gets a metric of 1562, while a T1 link gets a metric of 64.

If you have multiple links with high bandwidth, you might want to specify a larger number to differentiate the cost on those links. To do so, perform the following task in router configuration mode.

Command	Purpose
auto-cost reference-bandwidth *ref-bw*	Differentiate high bandwidth links.

5.7.12 Configure Route Calculation Timers

You can configure the delay time between when OSPF receives a topology change and when it starts a shortest path first (SPF) calculation.

To do this, perform the following task in router configuration mode.

Command	Purpose
timers spf *spf-delay*	Configure route calculation timers.

5.7.13 Refresh Timer Configuration

The originating router keeps track of the LSAs and performs refreshing LSAs when a refresh timer is reached.

You can configure the refresh time when OSPF LSAs gets refreshed and sent out. To do this, perform the following task in router configuration mode.

Command	Purpose
refresh *timer <10-1800>*	Configure the refresh timer. The time value is in seconds.

5.7.14 Redistribute Routes into OSPF

You can re-advertise route information in an OSPF routing domain and conditionally control the redistribution of routes between two domains by defining route maps.

Perform the following tasks associated with route redistribution in router configuration mode.

Command	Purpose
redistribute {kernel | connected | static | rip | bgp} [metric *metric-value*] **[metric-type {1|2}][route-map** *map-tag*]	Redistribute routes into OSPF routing domain.
default-metric *number*	Cause the OSPF routing protocol to use the same metric value for all redistributed routes.
default-information originate [metric *metric-value*] **[metric-type {1|2}]**	

5.7.15 Generate a Default Route

You can force an autonomous system boundary router to generate a default route into an OSPF routing domain. Whenever you specifically configure redistribution of routes into an OSPF routing domain, the router automatically becomes an autonomous system boundary router.

However, an autonomous system boundary router does not, by default, generate a *default route* into the OSPF routing domain.

To force the autonomous system boundary router to generate a default route, perform the following task in router configuration mode.

Command	Purpose
redistribute {kernel | connected | static | rip | bgp} [metric *metric-value*] **[metric-type {1|2}][route-map** *map-tag*]	Redistribute routes into OSPF routing domain.

5.7.16 Change the OSPF Administrative Distances

An administrative distance is a value that rates the trustworthiness of a routing information source, such as an individual router or a group of routers. Numerically, an administrative distance is an integer between 0 and 255. The higher the value, the lower the trust rating. An administrative distance of 255 means the routing information source cannot be trusted at all and should be ignored.

OSPF uses three different administrative distances: intra-area, inter-area, and external. Routes learned through other domains are external, routes to another area in OSPF domain are inter-area, and routes inside an area are intra-area. The default distance for each type of route is 110.

To change any of the OSPF distance values, use the following command in router configuration mode.

Command	Purpose
distance ospf {external *distance1* | **inter-area** *distance2* | **intra-area** *distance2*}	Change the OSPF administrative distance values.

5.7.17 Suppress Routes on an Interface

The interface specified as passive appears as a stub network in the OSPF domain. OSPF routing information is neither sent nor received through that specified router interface.

To suppress routes on a specified interface, use the following command in router configuration mode.

Command	Purpose
passive-interface *interface-name*	Suppress the sending of routes through the specified interface.

5.7.18 Prevent Routes from being Advertised in Routing Updates

To prevent other routers from learning one or more routes, you can suppress routes from being advertised in routing updates. Note that this feature applies only to external routes.

To suppress routes from being advertised in routing updates, perform the following task in router configuration mode.

Command	Purpose
distribute-list *list-name* **out {bgp | connected | kernel | rip | static}**	Permit or deny routes from being advertised in routing updates, depending upon the action listed in the access list.

5.7.19 Monitor and Maintain OSPF

You can display specific statistics such as the contents of IP routing tables and databases. The information provided can be used to determine resource utilization and solve network problems. You can also display information about node availability and discover the routing path that packets are taking through the network.

To display various routing statistics, use the following commands in top mode.

Command	Purpose
show ip ospf	Display general information about the OSPF routing process.
show ip ospf database **show ip ospf database {asbr-summary | external | network | nssa-external | router | summary}** **show ip ospf database {asbr-summary | external | network | nssa-external | router | summary}** *link -state-id* **show ip ospf database {asbr-summary | external | network | nssa-external | router | summary}** *link -state-id* **self-originate** **show ip ospf database {asbr-summary | external | network | nssa-external | router | summary}** *link -state-id* **adv-router** *ip-address* **show ip ospf database {asbr-summary | external | network | nssa-external | router | summary} self-originate** **show ip ospf database {asbr-summary | external | network | nssa-external | router | summary} adv-router** *ip-address* **show ip ospf database self-originate** **show ip ospf database max-age**	Display lists of information related to the OSPF database.
show ip ospf border-routers	Display the internal OSPF routing table entries for Area Border Router (ABR) and Autonomous System Boundary Router (ASBR).
show ip ospf route	Display OSPF routing table entries
show ip ospf interface *interface-name*	Display OSPF-related interface information

show ip ospf neighbor [*neighbor-id* | *interface-name*]	Display OSPF-neighbor information.

The debugging commands are useful to quickly diagnose problems. Use the following commands to display OSPF information in top mode.

Command	Purpose
debug ospf packet {hello | dd | ls-ack | ls-request | ls-update | all} [send | recv [detail]]	Display one set of information for each packet. The information includes the descriptions of packet database, link state requests, and their updates.
debug ospf event	Display information on OSPF-related events, such as adjacencies, flooding information, designated router selection, and SPF calculation.
debug ospf ism [events | status | timers]	Display flooding information, SPF calculation on internal area-related events.
debug ospf lsa [flooding | refresh]	Display flooding information, SPF calculation on OSPF-generate related events.
debug ospf nsm [events | status | timers]	Display information on adjacencies.
debug ospf nssa	Display OSPF NSSA information.
show debugging ospf	Display OSPF-related debugging messages

5.8 Virtual Router Redundancy Protocol (VRRP)

Virtual Router Redundancy Protocol (VRRP) specifies a protocol that dynamically elects a gateway router from among virtual routers running VRRP on a LAN. VRRP enables a group of routers to form a single virtual router. The LAN hosts can then be configured with the virtual router as their default gateway. The virtual router, representing a group of routers, is also known as a VRRP group, identified by a Virtual Router Identity (VRID). This allows hosts to maintain access to other networks without requiring configuration of dynamic routing or router discovery protocols on every end-host.

5.8.1 VRRP Configuration

All VRRP configuration commands are entered in the interface configuration mode.

Command	Purpose
ip vrrp *VRID* **ip** *A.B.C.D*	Enables VRRP on an interface and identifies the primary IP address of the virtual router.
ip vrrp *VRID* **description** *text*	Assigns a text description to the VRRP VRID group.
ip vrrp *VRID* **preempt**	Configures the router to take over as master virtual router for a VRRP VRID group if it has a higher priority than the current master virtual router. This command is enabled by default.

ip vrrp *VRID* **priority** *level*	Sets the priority level of the router within a VRRP VRID group. The default value is 100.
ip vrrp *VRID* **timers [advertise interval]**	Configures the interval between successive advertisements by the master virtual router in a VRRP VRID group.
ip vrrp *VRID* **authentication** *string*	Authenticates VRRP packets received from other routers in the VRID group. If you configure authentication, all routers within the VRRP VRID group must use the same authentication string.

The following commands are available under EXEC or Enable mode:

Command	**Purpose**
show vrrp [brief | VRID]	Displays a brief or detailed status of one or all VRRP VRID groups on the router.
show vrrp interface IFNAME [brief]	Displays the VRRP groups and their status on a specified interface.
debug ip vrrp	This command helps to debug VRRP operation. If this is enabled, then VRRP displays the debug messages onto the console.

5.9 Configuring ICMP Router Discovery Protocol (IRDP)

When IP routing is disabled, you can configure router discovery. The ICMP Router Discovery Protocol (IRDP) allows the router to dynamically learn about routes to other networks. When operating as a client, router discovery packets are generated. When operating as a host, router discovery packets are received. The IC35516 IRDP implementation fully conforms to the router discovery protocol outlined in RFC 1256.

The server/client implementation of router discovery does not actually examine or store the full routing tables sent by routing devices, it merely keeps track of which systems are sending such data.

5.9.1 Enable IRDP Processing

The only required task for configuring IRDP routing on a specified interface is to enable IRDP processing on that interface. Use the following command in interface configuration mode.

Command	**Purpose**
ip irdp	Enable IRDP processing on an interface.

5.9.2 Change IRDP Parameters

When IRDP processing is enabled, the default parameters will apply. You may change any of the following default parameters. Use the following commands in interface configuration mode.

Command	Purpose
ip irdp multicast	Send IRDP advertisements to the all-systems multicast address (224.0.0.1) on a specified interface.
ip irdp holdtime *seconds*	Set the IRDP period for which advertisements are valid.
ip irdp maxadvertinterval *seconds*	Set the IRDP maximum interval between advertisements.
ip irdp minadvertinterval *seconds*	Set the IRDP minimum interval between advertisements.
Ip irdp preference *number*	Set a device's IRDP preference level.

5. 10 Configuring Protocol-Independent Multicast Protocol (PIM)

The IC35516 supports PIM as specified in IETF RFC 2362. PIM can operate in dense mode or sparse mode. In PIM sparse mode, a multicast router (IC35516) assumes that other multicast routers do not have any receivers for a group until there is an explicit request for that group. When hosts join a multicast group, the directly-connected routers send PIM Join messages toward the rendezvous point (RP). The RP keeps track of multicast groups. Hosts that send multicast packets are registered with the RP by that host's immediate multicast router. The RP then sends Join messages toward the source. At this point, packets are forwarded on a shared distribution tree. If the multicast traffic from a specific source is sufficient, the receiver's immediate router may send Join messages toward the source to build a source-based distribution tree.

PIM uses the Bootstrap Router (BSR) to discover and announce RP-set information for each group prefix to all the routers in a PIM domain. To avoid a single point of failure, there are usually several candidate BSRs in a PIM domain. A BSR is elected from the candidate BSRs automatically, using bootstrap messages to discover which BSR has the highest priority. This router then announces to all PIM routers in the PIM domain that it is the BSR. Routers that are configured as candidate RPs then unicast to the BSR the group range for which they are responsible. The BSR includes this information in its bootstrap messages and announces it to all PIM routers in the domain. Based on this information, all routers can map multicast groups to specific RPs. As long as a router is receiving the bootstrap message, it has a recent RP-set.

5.10.1 Enabling PIM Sparse Mode

Use the **ip pim sparse mode** global configuration command to enable PIM and operate in sparse mode.

5.10.2 Setting Up BSR Candidacy

Use the following global configuration command to announce its candidacy as a BSR:

```
Router(config)# ip pim bsr-candidate <ifname> <has-mask-length> <priority>
```

- **Ifname**—Router interface from which the bootstrap router address is derived to indicate its candidacy.
- **Hash-mask-length**— Length of a mask (32-bit maximum) that is to be masked with the group address before the hash function is called.

- **Priority**—Priority of the bootstrap router in the range 0–255, with the larger priority being preferred. If the priority values are the same, the router with the larger IP address will be the preferred bootstrap router.

To delete this router as a candidate for being a bootstrap router, use the **no** form of this command:

5.10.3 Setting Up RP Candidacy

To configure the router to advertise itself as PIM candidate rendezvous point (RP) to the bootstrap router, use the following global configuration command:

```
Router(config)# ip pim rp-candidate <ifname>
```

- **Ifname**—IP address associated with this router interface is advertised as a candidate RP address.

To delete this router as a candidate for being an RP, use the **no** form of this command.

5.11 Enabling Directed Broadcast-to-Physical Broadcast Translation

By default, IP directed broadcasts are dropped that is they are not forwarded. Dropping IP directed broadcasts makes routers less susceptible to denial-of-service attacks.

You can enable forwarding of IP directed broadcasts on an interface where the broadcast becomes a physical broadcast.

To enable forwarding of IP directed broadcasts, use the **ip directed-broadcast** command in router interface configuration mode.

5.12 Monitoring and Maintaining the Network

You can monitor the network by displaying specific statistics such as the contents of IP routing tables and databases. The resulting information can be used to determine resource utilization and to solve network problems. You also can display information about node reach-ability and discover the routing path that your device's packets are taking through the network.

Use any of the following commands in top mode.

Command	Purpose
show arp [*interface*]	Display the entries in the ARP table.
show access-lists [*access-list-name*]	Display the contents of one or all current access lists.
show ip prefix-list [*prefix-list-name*]	Display the contents of current IP prefix lists.
show ip protocols	Display active IP routing protocol statistics.
show ip irdp	Display IRDP values.
show ip route [**bgp** | **rip** | **ospf** | **connected** | **kernel** | **static** | *address* | *prefix*]	Display the current state of the routing table.

ping {*host* | *address*}	Test network node reach-ability.
traceroute {*host* | *destination*}	Trace packet routes through the network.

5.13 Configuring EtherAggregate

An EtherAggregate consists of individual Gigabit Ethernet links bundled into a single logical link. The EtherAggregate feature allows you to manually configure multiple high-speed load-sharing links between two switch/routers or a switch/router and a server. You can configure up to four Gigabit ports as an aggregated port, which will form into a logical/virtual interface, supporting transfer rates of up to four Gbps of bi-directional traffic.

In addition to enabling loadsharing of traffic, EtherAggregate provides redundant, alternate paths for traffic if any of the segments fail.

NOTE: The ports in an EtherAggregate make a single logical link. Therefore, all the ports in an EtherAggregate must be connected to the same device at the other end.

5.13.1 Configuring L2 EtherAggregate

An EtherAggregate can be created using the following commands available in configuration mode. The newly created EtherAggregate will have a unique identifier. The available identifier will be 1–6, which means you can create 6 EtherAggregates with a maximum of 4 physical ports (eth1-eth16) in each EtherAggregate.

Command	**Purpose**
interface port-aggregate <port-aggregate-id>	Enter aggregate configuration mode, which is required for all the following commands.
access {vlan <vlan#>}	Configure an EtherAggregate group as an access mode.
description <line>	Add an aggregate specific description.
dot1qtrunk native vlan <#> or **dot1qtrunk allowed vlan** [add | remove | except] <VLAN list> [all | none]	Set dot1qtrunk characteristics: **allowed**: Set the list of allowed VLANs that can receive/send traffic on this aggregate in tagged format **native**: Set native VLAN for sending and receiving untagged traffic. Specify a VLAN list as a single VLAN number or a continuous range of VLANs described by two VLAN numbers separated by a hyphen; for example 2,4,5,6,8 or 2,4-6,8
mode [access | dot1q-trunk]	VLAN membership mode of this ether-aggregate group: access-mode VLAN or dot1q trunk mode VLAN. The default mode is access-mode VLAN, so the **no** form of the command will reset it to access-mode. In dot1q trunk mode, the default value of the native VLAN is 1 and the default allowed-vlan list contains all VLANs.
name	Aggregate name configuration.
port-member add <list>	Add the defined list of interfaces to the EtherAggregate. The

	default is no port member.
speed [100 | 1000]	Set the operating speed of the port aggregate to 100 or 1000 Mbps. Note that the speed will be applied only when the negotiation is disabled (that is, no auto-negotiation). By default, all added ports are configured to 1000 Mbps.

The **no** form of the commands will reset each parameter to its defaults, or if the default is that the parameter has no value, then it will be deleted. For example, the EtherAggregate is not created by default, so the **no** command for EtherAggregate, "**no port-aggregate** <port-aggregate-id>" will remove the aggregation.

You can use the following show command in enable mode to display the current EtherAggregate configuration setup on the router:

Command	**Purpose**
show port-aggregate *{port-aggregation-id>*	Display EtherAggregate information.

5.13.2 EtherAggregate Limitations and Restrictions

If improperly configured, some EtherAggregate are automatically disabled to avoid network loops and other problems. Follow these restrictions to avoid configuration problems:

- Configure an EtherAggregate with up to 2–4 Ethernet interfaces of the same type.
- Configure all interfaces in an EtherAggregate to operate at the same speeds and duplex modes.
- The difference of interface number in an EtherAggregate cannot be greater or equal than 8. For example, eth1 and eth9 cannot be in the same EtherAggregate.
- When an EtherAggregate is first created, all ports follow the parameters set for the primary port, which is the lowest port number to be added to the EtherAggregate. For example, out of eth2, eth5, eth1, the primary port will be eth1. If you change the configuration of one of these parameters, you must also make the changes to all ports in the EtherAggregate.
    - Allowed-VLAN list
    - Spanning-tree path cost
    - Spanning-tree port priority
- An EtherAggregate interface that is configured as a monitor or mirror port does not join the EtherAggregate until it is deconfigured as a mirror/monitor port. Do not configure a port that belongs to an EtherAggregate port group as a secure port.
- Assign all interfaces in the EtherAggregate to the same VLAN, or configure them as IEEE 802.1q trunks. Interfaces with different native VLANs cannot form an EtherAggregate.
- An EtherAggregate supports the same allowed range of VLANs on all the interfaces in a trunking Layer 2 EtherAggregate. If the allowed range of VLANs is not the same, the interfaces do not form an EtherAggregate.
- Interfaces with different spanning-tree path costs can form an EtherAggregate if they are otherwise compatibly configured. Setting different spanning-tree path costs does not, by itself, make interfaces incompatible for the formation of an EtherAggregate.

5.13.3 EtherAggregate Configuration Example

The following example creates four L3 EtherAggregates.

```
!
!  EtherAggregate example configuration file
!

...
// The below configures port-aggregate 1 with 1-4 eth ports with speed 1000 Mbps
// The Vlan Mode is default Access mode
//Access vlan is 1

interface port-aggregate 1
 name EtherAggregate 1
 description Engineering EtherAggregate
 port-member add eth 1-4

//the below configures port-aggregate 2 with  5-8 eth ports
// Vlan Mode is set to dot1qtrunk
//Even though the access vlan is set to 2, since the mode is dot1qtrunk all the
//configuration following dot1qtrunk mode takes effect
//  native vlan set to 2 and allowed vlan list set to all vlans on the system

interface port-aggregate 2
 name EtherAggregate 2
 description Marketing EtherAggregate
port-member add eth 5-8
access vlan 2
 mode dot1q-trunk
 dot1q-trunk native vlan 2
 dot1q-trunk allowed vlan add all

!
// The below configures port-aggregate 3 with 9-12 eth ports set to speed 100 Mbps

interface port-aggregate 3
 name EtherAggregate 3
 description Purchase EtherAggregate
port-member add eth 9-12
 access vlan 3
dot1q-trunk allowed vlan add 2-10
 speed 100

// The below configures port-aggregate 4 with 13-16 eth ports set to speed 1000 Mbps
// The Vlan Mode is  dot1qtrunk mode
//default is dot1qtrunk native vlan 1
// dot1q-trunk allowed vlan list is 1000-2000, 3000-3333 where 1000-2000,3000-3333 are
existing vlans

interface port-aggregate 4
 name EtherAggregate 4
 description Finance EtherAggregate
port-member add eth 13-16
 mode dot1q-trunk
 dot1q-trunk allowed vlan add 1000-2000, 3000-3333

end
```

5.14 802.1x Support

802.1x is a standard for passing Extensible Authentication Protocol (EAP) information over a network. This enables you to restrict network access on a per-port basis.

This section lists the commands needed to configure the IntraCore 35516 to act as an EAP authentication server. Please refer to the IEEE 802.1X standard (available on the web at standards.ieee.org/getieee802/) for details of the terminology.

5.14.1 Configuration Mode Commands

Command	Purpose
dot1x default	Sets 802.1x parameters to default values as follows: Sys-auth-ctrl disabled Max-req 2 seconds Quiet-period 60 seconds Re-authperiod 3600 seconds Server-timeout 30 seconds Supplicant-timeout 30 seconds Tx-period 30 seconds All interfaces are in “force-authenticated” mode. RADIUS server 192.168.0.1 Authentication port 1812 Shared key radius-key NAS-identifier IntraCore_35516-XXXXXX
dot1x sys-auth-ctrl [**enable** | **disable**]	Enables/disables the authentication feature of the switch.
dot1x max-req <1-10>	Sets the maximum number of times an EAP-request/identity frame is sent before restarting the authentication process.
dot1x re-authenticate [**interface** IFNAME]	Manually re-authenticate an interface or all interfaces.
dot1x re-authentication	Enables the automatic re-authentication state machine.
dot1x timeout quiet-period <0-65535>	Sets the period of the quietWhile timer.
dot1x timeout re-authperiod <1-4294967295>	Sets the period between re-authentication attempts.
dot1x timeout tx-period <1-65535>	Sets time in seconds to wait for a response to an EAP-request/identity frame from client before re-transmitting the request.
dot1x timeout supplicant-timeout <1-300>	Sets time in seconds to wait for supplicant timeout.
dot1x timeout server-timeout <1-300>	Sets time in seconds to wait for server timeout.

dot1x radius-server host A.B.C.D [**auth-port** <1-65535>] [**key** SHARED_KEY_STRING]	Defines a RADIUS server and its parameters.
dot1x radius-server key SHARED_KEY_STRING	Sets RADIUS server shared key.
dot1x radius-server nas-identifier NAS_ID_STRING	Sets RADIUS NAS-Identifier attribute.

5.14.2 Interface Configuration Mode Commands

Command	**Purpose**
dot1x multiple-hosts	Enables multiple-host mode so that after the interface is authenticated, it is accessible to all hosts on the port.
no dot1x multiple-hosts	Disables multiple-host mode so that after the interface is authenticated by a host, it is accessible only to that host.
dot1x port-control [**auto** | **force-authorized** | **force-unauthorized**]	Sets the interface to the operating mode below: **auto**: interface is subject to 802.1X control **force-authenticated**: interface is set to be always authenticated, so it is accessible to all traffic **force-unauthenticated**: interface is set to be unauthenticated, so it is blocking all traffic
no dot1x port-control	Sets 802.1X interface parameters to default values.
show dot1x [**detail** | **parameters** | **port-configuration** | **radius-server**]	Displays 802.1x information.

Chapter 6: VLAN Configuration

Up to 4094 Virtual LANs (VLANs) are supported on the IC35516. The switch is shipped with a default VLAN with VLAN ID (VID) 1. All switchports (eth1–eth16) are included in the default VID 1. **The default VID 1 cannot be deleted**.

6.1 Creating or Modifying a VLAN

Enter the following commands beginning in configuration mode:

Command	Purpose
vlan *vid*	Enter a VLAN ID (2–4094), which will access config-vlan mode. Enter a new VLAN ID to create a VLAN, or enter an existing VLAN ID to modify a VLAN.
name *vlan-name*	Enter a name for the VLAN (optional).
end	Return to Enable mode.
no vlan *vid*	Enter a VLAN ID (2-4094) to be removed.

Switchports are Layer 2-only interfaces associated with a physical port. A switchport is used as an access port. Switch ports are used for managing the physical interface and associated Layer 2 protocols and do not handle routing or bridging. Ports 1–16 on the 35516 are Ethernet ports. The following example demonstrates how to enter the interface configuration mode for port 16:

```
Router(config)# interface eth16
Router(config-if-eth16)#
```

From the interface configuration mode, use the **switchport** command to configure the access port or the Class of Service (CoS) default priority for the port.

An access port belongs to and carries the traffic of only one VLAN (see Virtual Interfaces, below.) Traffic is received and sent in native formats with no VLAN tagging. Traffic arriving on an access port is assumed to belong to the VLAN assigned to the port. If an access port receives a tagged packet (802.1Q tagged), the packet is dropped, and the source address is not learned. Static access ports are manually assigned to a VLAN.

```
Router(config-if-eth16)# switchport access vlan <1-4094>
```

6.1.1 Virtual Interfaces

A virtual interface represents a VLAN of switchports as one interface to the routing or bridging function in the system. Only one virtual interface can be associated with a VLAN, but it is only necessary to configure a virtual interface for a VLAN when you wish to route between VLANs or to provide IP host connectivity to the switch. By default, a virtual interface (veth1) is created for the default VLAN (VLAN 1) to permit remote switch administration. Additional virtual interfaces must be configured. In Layer 2 mode, virtual interfaces provide IP host connectivity only to the system; in Layer 3 mode, you can configure routing across virtual interfaces.

In order to create a virtual interface, it must be bound to a VLAN that has already been configured and bound in turn to a physical port or ports. The following examples show how to create a VLAN (with a VLAN ID of 2), how to select a port (interface eth9) to belong to the VLAN, and how to create a virtual interface (veth2) by binding it to VLAN 2.

First, a VLAN is created and named *tester*.

```
Router# configure terminal
Router(config)# vlan 2
Router(config-vlan)# name tester
Router(config-vlan)# exit
Router(config)# exit
Router# show vlan
```

In the output of the **show vlan** command, the new VLAN will be listed, but will not yet be active. Next, a switchport is chosen to belong to VLAN 2.

```
Router# configure terminal
Router(config)# interface eth9
Router(config-if-eth9)# switchport access vlan 2
Router(config-if-eth9)# exit
Router(config)# exit
Router# show vlan
```

In the output of the **show vlan** command, VLAN 2 will be listed as active, with eth9 listed as a member port. Repeat the previous step to add additional switchports to VLAN 2.

Finally, create a virtual interface by binding VLAN 2 to veth2. Use the **interface veth2 vlan 2** command from the global configuration mode.

```
Router(config)# interface veth2 vlan 2
Router(config-if-veth2)#
```

Now this virtual interface is ready to have an IP address assigned to it.

```
Router(config-if-veth2)# ip address 192.168.123.254/24
Router(config-if-veth2)# exit
Router(config)# exit
Router# write file
```

6.1.2 Deleting a VLAN

Beginning in global configuration mode, use the following example to delete a VLAN on the switch (VLAN 2 in this example):

```
Router(config)# no vlan 2
Router(config)# exit
Router# show vlan
```

Note: Remember, you cannot delete the default VLAN 1.

6.2 VLAN Port Membership Modes

A switchport can be assigned to a VLAN by designating a membership mode. The membership mode determines the kind of traffic the port carries and the number of VLANs to which it can belong. The membership modes are as follows:

- Static Access
- Trunk (IEEE 802.1Q)
- Dot1q Tunnel

6.2.1 Static Access

A static-access port can belong to one VLAN and is manually assigned to that VLAN. Use the following commands, beginning in config mode, to assign a static-access port to a VLAN:

Command	**Purpose**
interface IFNAME	Enter the interface name to access the interface configuration mode.
switchport mode access	This command designates the interface as static-access mode.
switchport access vlan *vid*	This command assigns the interface to the VLAN *VID.* Use the **no** form of this command to reset the static-access VLAN to default VID 1.
end	Return to Enable mode.

6.2.2 Trunk (IEEE 802.1Q)

By default, a trunk port is a member of all VLANs. However, membership can be limited by configuring a *VLAN Allowed List*.

Use the following commands, beginning in config mode, to assign an IEEE 802.1q trunk port:

Command	**Purpose**
interface IFNAME	Enter the interface name to access the interface configuration mode.
switchport mode trunk	This command designates the interface as IEEE 802.1q trunk-access mode. Use the **no** form of this command to reset to the default of static-access mode.
switchport trunk native vlan *vid*	This command will assign the native VLAN for the trunk port. Use the **no** form of this command to reset the native VLAN to VID 1.

Router(config-if-IFNAME)# end	Return to Enable mode.

Use the following commands, beginning in config mode, to configure the *VLAN Allowed List* for the trunk port:

Command	**Purpose**
interface *IFNAME*	Enter the interface name to access the interface configuration mode.
switchport mode trunk	This command designates the interface as IEEE 802.1q trunk-access mode. Use the **no** form of this command to reset to the default of static-access mode.
switchport trunk allowed vlan {**add** | **all** | **except** | **remove**} *vlan-list*	This command will configure the VLAN Allowed List for the trunk port. **add**—Add VLANs to the current VLAN list. **all**—Add all VLANs to the allowed-VLAN list. **except**—Add all VLANs except those specified in the VLAN list. **remove**—Remove the VLANs specified in the VLAN list. **vlan-list**—The VLAN list can be a single VLAN or a range of VLANs (from 1–4094). Separate the VID numbers by a comma, or by a hyphen when listing a range (e.g., “120, 158, 4090-4094”). Use the **no** form of this command to reset to default setting of all VLANs in the VLAN Allowed List.
end	Return to Enable mode.

The trunk port accepts tagged and untagged frames. All the untagged frames are classified to the trunk port’s native VLAN (the VLAN whose VID matches the port’s VLAN ID). The trunk port also sends out the frames as untagged for the native VLAN. Using the following global configuration command can change this behavior:

Command	**Purpose**
Router(config)# vlan dot1q tag native	This global command enables tagging of native VLAN frames on all 802.1Q trunk ports. Use the **no** form of this command to disable tagging of native VLAN frames.
Router(config)# end	Return to Enable mode.

6.2.3 Dot1q Tunnel

802.1Q tunnel ports are used to maintain customer VLAN integrity across a service provider network. You can configure a tunnel port on an edge switch in the service provider network and connect it to an 802.1Q trunk port on a customer interface, creating an asymmetric link. A tunnel port belongs to a single VLAN that is dedicated to tunneling.

Use the following commands, beginning in config mode, to configure an interface as an IEEE 802.1q tunnel port:

Command	**Purpose**
interface *ifname*	Enter the interface name to access the interface configuration mode.
switchport mode dot1q-tunnel	This command will put the interface into IEEE 802.1q dot1q-tunnel access mode. Use the **no** form of this command to reset to the default of static-access mode.
switchport access vlan *vid*	This command will assign a VLAN ID specific to the particular customer. Use the **no** form of this command to reset the access VLAN to default VID 1.
End	Return to Enable mode.

Chapter 7: Quality of Service (QoS) Configuration

Quality of Service (QoS) is a general term referring to various methods of traffic management you can employ on your network to ensure that traffic you identify as high-priority can use a sufficient share of the available bandwidth. The IC35516 supports the following QoS methods:

- Weighted Fair Queuing
- Priority Queuing
- Custom Queuing

7.1 Weighted Fair Queuing

Weighted Fair Queuing (WFQ) is a dynamic scheduling method that provides fair bandwidth allocation to all network traffic. WFQ applies priority, or weights, to traffic to classify it into conversations and determine how much bandwidth each conversation is allowed. WFQ schedules interactive traffic to the front of a queue to reduce response time and fairly shares the remaining bandwidth.

7.1.1 Configuring Flow-Based Weighted Fair Queuing Configuration

For flow-based WFQ, packets are classified by flow. Packets with the same source IP address, destination IP address, source TCP or UDP port, destination TCP or UDP port, and protocol belong to the same flow. The bandwidth allocation is determined by the precedence field in the IP header. To enable this feature, use the **fair-queue** command in interface configuration mode:

When you enable flow-based WFQ, the following table applies:

IP Precedence	Bandwidth
0	1/36
1	2/36
2	3/36
3	4/36
4	5/36
5	6/36
6	7/36
7	8/36

7.1.2 Configuring Type of Service-Based WFQ

Type of service (ToS)-based WFQ allocates bandwidth based on the lower order 2 bits of the 6-bit DiffServ/Precedence field in the IP header. The range of ToS is 1–3. To configure type of service (ToS)-based WFQ, use the following commands in interface configuration mode:

Command	Purpose
fair-queue tos	Enables ToS-based WFQ. Defaults are 0:10%, 1:20%, 2:30%, 3:40%
fair-queue tos *number* ***bandwidth*** percentage	For each ToS class, specifies the percentage of the bandwidth to be allocated to each class. (Optional)

7.1.3 Monitoring Weighted Fair Queuing Lists

To display information about the input and output queues, use the following command in EXEC mode:

Command	Purpose
show queuing fair	Displays the status of the weighted fair queuing.

7.1.4 Weighted Fair Queuing Example

This example shows eth10 has 10% bandwidth for class 3, 20% for class 2, 30% for class 1, and 40% for class 0.

```
router(config)# interface eth10
router(config-if)# fair-queue tos
router(config-if)# fair-queue tos 3 bandwidth 10
router(config-if)# fair-queue tos 2 bandwidth 20
router(config-if)# fair-queue tos 1 bandwidth 30
```

7.2 Priority Queuing

Priority Queuing (PQ) allows you to define how traffic is prioritized in the switch. You configure four traffic priorities. You can define a series of filters based on packet characteristics to cause the router to place traffic into these four queues; the queue with the highest priority is serviced first until it is empty, then the lower queues are serviced in sequence.

7.2.1 Defining the Priority List

A priority list contains the definitions for a set of priority queues. The priority list specifies in which queue a packet will be placed.

In order to perform queuing using a priority list, you must assign the list to an interface. The same priority list can be applied to multiple interfaces. Alternatively, you can create many different priority policies to apply to different interfaces.

7.2.2 Assigning Packets to Priority Queues

Assign packets to priority queues based on the following criteria:

- Protocol type
- Interface where the packets enter the router

You can specify multiple assignment rules. The **priority-list** commands are read in order of appearance until a matching protocol or interface type is found. When a match is found, the packet is assigned to the appropriate queue and the search ends. Packets that do not match other assignment rules are assigned to the default queue.

To specify in which queue to place a packet, use the following commands in global configuration mode:

Command	Purpose
priority-list *list-number* **protocol IP** {**high** | **medium** | **normal** | **low**}	Establishes queuing priorities based on the protocol type.

{**list** | **tcp** | **udp**} access-list-number/*layer4-port-number*	
priority-list *list-number* **interface** *interface-type-number* {**high** | **medium** | **normal** | **low**}	Establishes queuing priorities for packets entering from a given interface.
priority-list *list-number* **default** {**high** | **medium** | **normal** | **low**}	Assigns a priority queue for those packets that do not match any other rule in the priority list. This is optional. If not defined, unmatched packets will be placed in normal priority queue.

7.2.3 Assigning the Priority List to an Interface

You can assign a priority list number to an interface. Only one list can be assigned per interface. To assign a priority group to an interface, use the following commands, beginning in global configuration mode:

Command	Purpose
interface *interface-type-number*	Specifies the interface and enters interface configuration mode.
priority-group *list-numbe*r	Assigns a priority list number to the interface.

7.2.4 Monitoring Priority Queuing Lists

To display information about the input and output queues, use the **show queueing priority** command in EXEC mode, as needed:

7.2.5 Priority Queuing Example

This example configures the access-list 1 traffic going out on interface 15 to have a medium priority.

Defining the access list:

```
router(config)# access-list 1 permit 192.203.54.56
```

Defining the priority list:

```
router(config)# priority-list 2 protocol ip medium list 1
```

Assigning the priority list to an interface:

```
router(config)# interface eth15
router(config-if)# priority-group 2
```

7.3 Custom Queuing

Custom Queuing (CQ) allows you to specify a certain number of bytes to forward from a queue each time the queue is serviced, thereby allowing you to share the network resources among applications with specific minimum bandwidth or latency requirements. You can also specify a maximum number of packets in each queue.

You must follow certain required, basic steps to enable CQ for your network. In addition, you can choose to assign packets to custom queues based on protocol type, interface where the packets enter the router, or other criteria you specify. Like priority queue list, custom queue is used on an output interface.

7.3.1 Defining the Custom Queue List

To assign a custom queue list to an interface, use the following commands beginning in global configuration mode:

Note: Use the **custom-queue-list** command in place of the **priority-list** command. Only one queue list can be assigned per interface.

CQ allows a fairness not provided with priority queuing (PQ). With CQ, you can control the available bandwidth on an interface when it is unable to accommodate the aggregate traffic enqueued. Associated with each output queue is a configurable byte count, which specifies how many bytes of data should be delivered from the current queue by the system before the system moves on to the next queue. When a particular queue is being processed, packets are sent until the number of bytes sent exceeds the queue byte count defined by the **queue-list queue byte-count** command, or until the queue is empty.

7.3.1 Specifying the Minimum Size of the Custom Queues (Optional)

You can specify the approximate number of bytes to be forwarded from each queue during its turn in the cycle. The number is an average number, because whole packets must be forwarded.

To specify the approximate number of bytes to be forwarded from each queue during its turn in the cycle, use the following command in global configuration mode, as needed:

```
Router(config)# queue-list list-number queue queue-number byte-count byte-count-number
```

This designates the average number of bytes forwarded per queue. The *byte-count-number* argument specifies the average number of bytes the system allows to be delivered from a given queue during a particular cycle.

7.3.1 Assigning Packets to Custom Queues

You can assign packets to custom queues based on the protocol type or interface where the packets enter the router. Additionally, you can set the default queue for packets that do not match other assignment rules. You can also specify multiple rules.

To define the CQ lists, use the following commands in global configuration mode, as needed:

Command	Purpose
queue-list *list-number* **protocol IP** *queue-number* { **list**|**tcp**|**udp**} access-list-number/*layer4-port-number*	Establishes queueing priorities based on the protocol type.
queue-list *list-number* **interface** *interface-type-number queue-number*	Establishes CQ based on packets entering from a given interface.
queue-list *list-number* **default** *queue-number*	Assigns a queue number for those packets that do not match any other rule in the custom queue list (optional).

When you use multiple rules, remember that the system reads the **queue-list** commands in order of appearance. When classifying a packet, the system searches the list of rules specified by the **queue-list** commands for a

matching protocol or interface type. When a match is found, the packet is assigned to the appropriate queue. The list is searched in the order it is specified, and the first matching rule terminates the search.

7.3.1 Assigning the Queue List to an Interface (Optional)

You can assign a custom queue list number to an interface. Only one list can be assigned per interface. To assign a custom queue group to an interface, use the following commands beginning in global configuration mode:

Command	Purpose
interface *interface-type-number*	Specifies the interface and enters interface configuration mode.
custom-queue-list *list-number*	Assigns a queue list number to the interface.

7.3.1 Monitoring Custom Queue Lists

To display information about the input and output queues when CQ is enabled on an interface, use the following commands in EXEC mode, as needed:

Command	Purpose
show queueing custom	Displays the status of the CQ lists.
show interfaces *interface-name*	Displays the current status of the custom output queues when CQ is enabled.

7.3.1 Custom Queuing Example

This example configures the telnet traffic to eth13 to have a minimum bandwidth of 80M.

Defining the queue minimum bandwidth:

```
router(config)# queue-list 2 queue 4 byte-count 10240000
```

Defining the queue list:

```
router(config)# queue-list 2 protocol ip 4 tcp 23
```

Assigning the priority list to an interface:

```
router(config)# interface eth13
router(config-if)# custom-queue-list 2
```

7.4 Generic Traffic Shaping

Traffic shaping allows you to control the traffic going out from an interface in order to match its flow to the speed of the remote target interface and to ensure that the traffic conforms to policies contracted for it.

Thus, traffic adhering to a particular profile can be shaped to meet downstream requirements, thereby eliminating bottlenecks in topologies with data-rate mismatches.

7.4.1 Configuring GTS for an Interface

To configure GTS for outbound traffic on an interface, use the following command in interface configuration mode:

```
Router(config-if)# traffic-shape rate bit-rate
```

7.4.2 Configuring GTS for an Access List

To configure GTS for outbound traffic on an access list, use the following commands beginning in global configuration mode:

Command	Purpose
access-list *access-list-number*	Assigns traffic to an access list.
interface *interface-type-number*	Enters interface configuration mode.
traffic-shape group *access-list-number* ***bit-rate***	Configures traffic shaping for outbound traffic on an interface for the specified access list.

Repeat the steps for each type of traffic you want to rate limit.

7.4.3 Monitoring the GTS Configuration

To monitor the current traffic shaping configuration and statistics, use the following commands in EXEC mode, as needed:

Command	Purpose
show traffic-shape [*interface-type-number*]	Displays the current traffic shaping configuration.

7.4.4 Generic Traffic Shaping Example

This example configures that the DNS traffic to eth13 have maximum bandwidth of 50M.

Defining the access list:

```
router(config)# access-list 100 permit udp any any eq 53
```

Assigning the traffic shape to an interface:

```
router(config-if)# traffic-shape group 100 51200000
```

7.5 Random Early Detection

Random Early Detection (RED) is a congestion avoidance mechanism that takes advantage of the congestion control mechanism of TCP. By randomly dropping packets prior to periods of high congestion, RED tells the packet source to decrease its transmission rate. RED drops packets selectively based on IP precedence. Edge routers assign IP precedences to packets as they enter the network.

7.5.1 Configuring RED to Use IP Precedence

To configure RED to use the IP precedence value when it calculates the drop probability, use the following commands in interface configuration mode:

Command	Purpose
random-detect prec-based	Indicates that RED is to use the ip precedence value when it calculates the drop probability for the packet.
random-detect precedence precedence value **{high | medium | normal | low}**	Specifies the drop probability.

The following are the default drop probability values:

Precedence Value	Drop Probability
0	high
1	high
2	medium
3	medium
4	normal
5	normal
6	low
7	low

7.5.2 Configuring RED to Use DSCP

To configure RED to use the IP precedence value when it calculates the drop probability, use the following commands in interface configuration mode:

Command	Purpose
random-detect dscp-based	Indicates that RED is to use the IP precedence value when it calculates the drop probability for the packet.
random-detect precedence dscpevalue **(high|medium|normal|low)**	Specifies the drop probability. The default value is normal.

7.5.3 Monitoring RED (Optional)

Use the **show queuing random-detect** command to show RED information.

Chapter 8: Configuring DHCP and DNS

8.1 DHCP

Dynamic Host Control Protocol (DHCP) allows users to automatically assign re-usable IP addresses to DHCP clients. The router software supports a full DHCP server implementation that assigns and manages IP addresses from specified address pools within the router to DHCP clients.

8.1.1 Enabling DHCP Server

By default, the DHCP server function is disabled on your device. To enable it, issue the **service dhcp** command.

Use the **no** form of this command to disable the DHCP server feature.

8.1.2 Enabling DHCP Address Conflict Logging

By default, DHCP address conflict logging is disabled. To enable it, issue the **ip dhcp conflict logging** command.

Use the **no** form of this command to disable the DHCP address conflict logging.

8.1.3 Configuring DHCP Address Pool

A DHCP address pool can be configured with a name that is a symbolic string (such as “Marketing”) or an integer number. Configuring a DHCP address pool also places you in DHCP pool configuration mode—identified by the `(config-dhcp)#` prompt—from which you can configure pool parameters (for example, the IP subnet number and default router list).

To configure the DHCP address pool name and enter DHCP pool configuration mode, use the following command in global configuration mode:

```
Router(config)# ip dhcp pool name
```

Use the **no** form of this command to remove the configured DHCP address pool.

8.1.4 Configuring the DHCP Address Pool Subnet and Mask

To configure a subnet and mask for the newly created DHCP address pool, which contains the range of available IP addresses that the DHCP server may assign to clients, use the following command in DHCP pool configuration mode:

Note: You cannot configure manual bindings within the same pool that is configured with the **network** command. To configure manual bindings, see the “Configuring Manual Bindings” section later in this chapter.

```
Router(config-dhcp)# network A.B.C.D/M
```

Use the **no** form of this command to remove the configured DHCP address pool subnet/mask.

8.1.5 Configuring the Domain Name for the Client

The domain name of a DHCP client places the client in the general grouping of networks that make up the domain. To configure a domain name string for the client, use the following command in DHCP pool configuration mode:

```
Router(config-dhcp)# domain-name domain
```

Use the **no** form of this command to remove the configured domain name.

8.1.6 Configuring the Domain Name System IP Servers for the Client

DHCP clients query DNS IP servers when they need to correlate host names to IP addresses. To configure the DNS IP servers that are available to a DHCP client, use the following command in DHCP pool configuration mode:

```
Router(config-dhcp)# dns-server A.B.C.D
```

Note: You can specify up to eight DNS server IP addresses.

Use the **no** form of this command to remove the configured DNS server.

8.1.7 Configuring the NetBIOS Node Type for the Client

The NetBIOS node type for Microsoft DHCP clients can be one of four settings: broadcast, peer-to-peer, mixed, or hybrid. To configure the NetBIOS node type for a Microsoft DHCP, use the following command in DHCP pool configuration mode:

```
Router(config-dhcp)# netbios-node-type type
```

Use the **no** form of this command to reset to default NetBIOS type.

8.1.8 Configuring the NetBIOS Name Server for the Client

To configure NetBIOS Windows Internet Naming Service (WINS) name servers that are available to Microsoft Dynamic Host Configuration Protocol (DHCP) clients, use the **netbios-name-server** DHCP pool configuration command. Use the **no** form of this command to remove the NetBIOS name server list.

```
Router(config-dhcp)# netbios-name-server A.B.C.D
```

8.1.9 Configuring the Next Server for the Client

To configure the next server in a Dynamic Host Configuration Protocol (DHCP) client's boot process, use the **next-server** DHCP pool configuration command. Use the **no** form of this command to remove the boot server list.

```
Router(config-dhcp)# next-server A.B.C.D
```

8.1.10 Configuring the Default Router for the Client

After a DHCP client has booted, the client begins sending packets to its default router. The IP address of the default router should be on the same subnet as the client. To configure a default router for a DHCP client, use the following command in DHCP pool configuration mode:

```
Router(config-dhcp)# default-router A.B.C.D
```

Note: You can specify up to eight DNS server IP addresses.

Use the **no** form of this command to remove the configured default router.

8.1.11 Configuring the Address Lease Time

By default, each IP address assigned by a DHCP server comes with a one-day lease, which is the amount of time that the address is valid. To change the lease value for an IP address, use the following command in DHCP pool configuration mode:

```
Router(config-dhcp)# lease <1-43200>
```

The numeric argument is the duration of the lease in minutes. Use the **no** form of this command to reset to the default one-day lease.

8.1.12 Configuring a DHCP Server Boot File

The boot file is used to store the boot image for the client. The boot image is generally the operating system the client uses to load. To specify a boot file for the DHCP client, use the following command in DHCP pool configuration mode:

```
Router(config-dhcp)# bootfile filename
```

Use the **no** form of this command to remove the DHCP Server Boot File.

8.1.13 Configuring the DHCP Address Range

To specify the IP Addresses (single or range) to be dynamically assigned, use the following command in DHCP pool configuration mode:

```
Router(config-dhcp)# range A.B.C.D [A.B.C.D]
```

Use the **no** form of this command to remove the address range.

8.1.14 Configuring Manual Bindings

An address binding is a mapping between the IP address and Media Access Control (MAC) address of a client. The IP address of a client can be assigned manually by an administrator or assigned automatically from a pool by a DHCP server.

Manual bindings are IP addresses that have been manually mapped to the MAC addresses of hosts that are found in the DHCP database. Manual bindings are stored in flash file on the DHCP server. Manual bindings are just special address pools. There is no limit on the number of manual bindings, but you can only configure one manual binding per host pool.

Automatic bindings are IP addresses that have been automatically mapped to the MAC addresses of hosts found in the DHCP database. To configure a manual binding, first create a host pool, then specify the IP address and hardware address of the client or client identifier. The hardware address is the MAC address. The client identifier, which is required for Microsoft clients instead of hardware addresses, is formed by combining the media type and the

MAC address of the client. Refer to the “Address Resolution Protocol Parameters” section of RFC 1700, *Assigned Numbers*, for a list of media type codes.

To configure manual bindings, use the following commands beginning in global configuration mode:

```
Router(config)# ip dhcp pool name
```

Use the **no** form of this command to remove the configured DHCP address pool.

```
Router(config-dhcp)# host-addr A.B.C.D/M
```

Specifies the IP address and subnet mask (in prefix length) of the client.

The prefix length specifies the number of bits that comprise the address prefix. The prefix is an alternative way of specifying the network mask of the client.

Use the **no** form of this command to remove the configured manual binding.

```
Router(config-dhcp)# hardware-address H:H:H:H:H:H
```

Specifies a hardware address (MAC Address) for the client.

Use the **no** form of this command to remove the configured hardware address.

```
Router(config-dhcp)# client-identifier unique-identifier
```

Specifies the distinct identification of the client in dotted-hexadecimal notation, for example, 014a.9f16.9b4c.dd, where 01 represents the Ethernet media type.

Use the **no** form of this command to remove the configured client-identifier.

```
Router(config-dhcp)# client-name name
```

Specifies the name of the client using any standard ASCII character. (Optional) The client name should not include the domain name. For example, the name **moon** should not be specified as **moon.asante.com**.

Use the **no** form of this command to remove the configured client name.

8.1.15 Monitoring and Maintaining the DHCP Server

To clear DHCP server variables, use the following commands in privileged EXEC mode, as needed:

Command	Purpose
clear ip dhcp binding *address* | *****	Deletes an automatic address binding from the DHCP database. Specifying *address* clears the automatic binding for a specific (client) IP address whereas specifying asterisk (*) clears all automatic bindings.
clear ip dhcp conflict *address* | *****	Clears an address conflict from the DHCP database. Specifying *address* clears the conflict for a specific IP address, while specifying an asterisk (*) clears conflicts for all addresses.
clear ip dhcp server statistics	Resets all DHCP server counters to 0.

To display DHCP server information, use the following commands in privileged EXEC mode, as needed:

Command	Purpose
show ip dhcp	Displays the current DHCP information.
show ip dhcp binding	Displays the DHCP address binding information.
show ip dhcp conflict	Displays the DHCP address conflict information.
show ip dhcp server statistics	Displays the DHCP server statistics.

8.2 DNS

DNS support on the IC35516 is limited to client mode; the switch makes a client DNS request to the name servers, and the returned host entry is saved in a cache to increase the performance of the resolver module.

8.2.1 Configuring DNS

To configure DNS, enter the following commands in global configuration mode:

Command	Purpose
ip domain-lookup	Enables DNS-based host name-to-address/address-to-name translation.
no ip domain-lookup	Disables DNS-based host name-to-address/address-to-name translation.
ip name-server A.B.C.D	Specifies the address of DNS name servers.
no ip name-server A.B.C.D	Deletes the address of DNS name servers.
ip domain-name WORD	Defines a default domain name that the software uses to complete unqualified host names (names without a dotted-decimal domain name). Do not include the initial period that separates an unqualified name from the domain name.
no ip domain-name	Removes the default domain name.
ip domain-list WORD	Defines a list of domains, each to be tried in turn. If there is no domain list, the domain name that is specified with the **ip domain-name** global configuration command will be used.
no ip domain-list WORD	Removes the domain name specified in WORD.
ip ospf name-lookup	Configures Open Shortest Path First (OSPF) to look up DNS names for use in all OSPF **show EXEC** command displays. This feature makes it easier to identify a router because the router is displayed by name rather than by its router ID or neighbor ID.

8.2.2 Design Limitation and Restrictions

- A maximum of 3 name servers can be specified.
- Each server is tried for 4 times with 5 seconds of timeout, so if you configure the router with 3 name servers and if all three of them are not available, the DNS resolver will wait for 60 seconds before it gives up. User interruption is not allowed during the wait.
- Each of the domains mentioned in the domain-list is queried within the wait time.

8.2.3 Configuration Example

The following example enables DNS lookup on the router and specified name servers and domain names.

```
!

!  DNS example configuration file

!
vlan 1
 name Engineering VLAN
vlan 2
 name Marketing VLAN
vlan 3
 name Purchase VLAN
vlan 4
 name Finance VLAN
ip domain-lookup
ip name-server 192.108.250.1
ip name-server 192.108.250.4
ip name-server 192.108.250.5
ip domain-name asante.com
ip domain-list stanford.edu
ip route 0.0.0.0/0 192.203.54.1
!
end
```

After the DNS lookup is enabled on the router, you can use the **ping** or **traceroute** command with the hostname rather than an IP address as in this example:

```
Router# ping www.yahoo.com
Translating "www.yahoo.com" …
Reply from…
```

Appendix A: Basic Troubleshooting

In the unlikely event that the switch does not operate properly, follow the troubleshooting tips below. If more help is needed, contact Asanté's technical support at www.asante.com/support.

Problem	Possible Solutions
The Power LED is not lit.	LED will turn off during system initialization. Check the power connection. Plug the power cord into another known working AC outlet. The primary power supply has failed. Install the optional emergency power supply and have the primary power supply serviced as soon as possible.
The Emergency Power LED is not lit.	This is normal. The emergency power supply LED will only light if the primary power supply fails and the unit takes over powering the switch.
The 10/100/1000 port Link LEDs are not lit.	Check the cable connections. Make sure the connectors are seated correctly in each port, and that the correct type of cable is used in each port. See *Chapter 2.6: Connecting to the Network* for more information.
The GBIC Link LED is not lit.	Check the GBIC connector. Make sure the cables are inserted correctly, with the Transmit (Tx) connector on one side of the link connected to the Receive (Rx) connector on the other side of the link.
Cannot establish communication to another device (switch, router, workstation, etc.).	• Make sure the Link LED for the port in use is on. Make sure the correct cable type is used. See *Chapter 2.6 Connecting to the Network* for more information on cabling procedures • Make sure the IP address, subnet mask, and VLAN membership of the switch are correct • Make sure the switch port and the device are both in the same VLAN • Try to connect to a different port
Cannot auto-negotiate the port speed.	Make sure that auto-negotiation is supported and enabled on both sides of the link (in both devices).

Appendix B: Specifications

The sections below list the features and product specifications for the IntraCore 35516 Series Gigabit Ethernet switches.

Connectors:	Gigabit Ethernet with Auto-Uplink™ (10/100/1000BaseTX): RJ-45 or GBIC holder for GBIC transceiver module
Console:	Serial (RS-232): DB9
Status Indicators:	Separate link-activity, speed (10/100/Gigabit) and duplex (full or half) LEDs for each port; system power, emergency backup power

Physical Characteristics

Dimensions:	IC35516-T: 17.1 x 10.1 x 1.6" (434 x 257 x 41 mm); 1 RU height IC35516-G: 17.5 x 14.0 x 2.6" (445 x 356 x 66 mm); 1 RU height
Mounting:	Install into a standard 19" rack or place on a desktop; rackmount kit and rubber feet included

Environmental Range

Operating Temperature:	32º to 104ºF (0º to 40ºC)
Relative Humidity:	10% to 90% non-condensing
Power:	Auto-switching, 110-240 VAC, 50/60 Hz; grounded IEC cord
Redundant DC Power:	12 VDC Auto-switching from main 110/240 VAC for emergency backup

B.1 Standards Compliance

IEEEE:	IEEE 802.1D spanning tree and bridge filters IEEE 802.1p prioritization (class of service) IEEE 802.1Q virtual LAN (VLAN) IEEE 802.3x full duplex and flow control IEEE 802.3z 1000BaseSX over 50µ multi-mode fiber; max. 1,804' (550 m) IEEE 802.3ab 1000BaseT over Category 5 UTP (4 pairs); max. 328' (100 m) IEEE 802.3u 100BaseTX over Category 5 UTP (2 pairs); max. 328' (100 m) IEEE 802.3 10BaseT over Category 3 UTP (2 pairs); max. 328' (100 m)
IETF:	RFC 1155 SMI RFC 1157 SNMP RFC 1212, 1213, 1215 MIB II and Traps RFC 1493 Bridge MIB RFC 1724 RIPv2 MIB RFC 1757 RMON 4 Groups (Statistics, History, Alarms, and Events) RFC 2096 IP-FORWARD-MIB RFC 2674 Bridge Extensions Asanté Private MIB
Safety:	UL 1950, cUL, TUV/GS
Emissions:	FCC Class A, CE

B.2 Technical Support and Warranty

IntraCare™:	Free technical support and advanced warranty support for 3 years. Includes free telephone support, 24-hour support via web and ftp, complete product warranty with second business day (within the United States) advanced replacement, and software maintenance agreement.
AsantéCare™:	Optional extended technical support and product warranty for 1–2 additional years.

See *Appendix C: FCC Compliance and Warranty Statements* for more detailed information.

Appendix C: FCC Compliance and Warranty Statements

C.1 FCC Compliance Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case you will be required to correct the interference at your own expense.

C.2 Important Safety Instructions

Caution: Do not use an RJ-11 (telephone) cable to connect network equipment.

1. Read all of these instructions.
2. Save these instructions for later use.
3. Follow all warnings and instructions marked on the product.
4. Unplug this product from the wall outlet before cleaning. Do not use liquid cleaners or aerosol cleaners. Use a damp cloth for cleaning.
5. Do not use this product near water.
6. Do not place this product on an unstable cart or stand. The product may fall, causing serious damage to the product.
7. The air vent should never be blocked (such as by placing the product on a bed, sofa or rug). This product should never be placed near or over a radiator or heat register. This product should not be placed in a built-in installation unless proper ventilation is provided.
8. This product should be operated from the type of power source indicated on the marking label. If you are not sure of the type of power available, consult your dealer or local power company.
9. This product is equipped with a three-wire grounding type plug, which is a plug having a third (grounding) pin. This plug will only fit into a grounding type power outlet. This is a safety feature. If you are unable to insert the plug into the outlet, contact your electrician to replace your outlet. Do not defeat the purpose of the grounding type plug.
10. Do not allow anything to rest on the power cord. Do not place this product where people will walk on the cord.
11. If an extension cord is used with this product, make sure that the total ampere ratings on the products into the extension cord do not exceed the extension cord ampere rating. Also make sure that the total of all products plugged into the wall outlet does not exceed 15 amperes.
12. Never push objects of any kind into this product through air ventilation slots as they may touch dangerous voltage points or short out parts that could result in a risk of fire or electric shock. Never spill liquid of any kind on the product.
13. Do not attempt to service this product yourself, as opening or removing covers may expose you to dangerous voltage points or other risks. Refer all servicing to service personnel.

C.3 IntraCare Warranty Statement

Products:	IntraCore 35516-T IntraCore 35516-G
Duration:	3 years
Advanced Warranty	United States: Second Business Day
Replacement:	Other Countries: See your local distributor or reseller.

1. Asanté Technologies warrants (to the original end-user purchaser) the covered IntraCore products against defects in materials and workmanship for the period specified above. If Asanté receives notice of such defects during the warranty period, Asanté will, at its option, either repair or replace products that prove to be defective. Replacement products may be either new or like-new.

2. Asanté warrants that Asanté software will not fail to execute its programming instructions, for the period specified previously, due to defects in material and workmanship when properly installed and used. If Asanté receives notice of such defects during the warranty period, Asanté will replace software media that does not execute its programming instructions due to such defects.

3. Asanté does not warrant that the operation of Asanté products will be uninterrupted or error free. If Asanté is unable, within a reasonable time, to repair or replace any product to a condition as warranted, customer would be entitled to a refund of the pro-rated purchase price upon prompt return of the product.

4. Asanté products may contain remanufactured parts equivalent to new in performance.

5. The warranty period begins on the date of delivery or on the date of installation if installed by Asanté.

6. Warranty does not apply to defects resulting from (a) improper or inadequate maintenance or calibration, (b) software, interfacing, parts, or supplies not received from Asanté, (c) unauthorized modification or misuse, (d) operation outside of the published environmental specifications for the product, or (e) improper site preparation or maintenance. This warranty expressly excludes problems arising from compatibility with other vendors' products, or future compatibility due to third-party software or driver updates.

7. TO THE EXTENT ALLOWED BY LOCAL LAW, THE PREVIOUS WARRANTIES ARE EXCLUSIVE AND NO OTHER WARRANTY OR CONDITION, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED AND ASANTÉ SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY, SATISFACTORY QUALITY, AND FITNESS FOR A PARTICULAR PURPOSE.

8. Asanté will be liable for damage to tangible property per incident up to the greater of $10,000 or the actual amount paid for the product that is the subject of the claim, and for damages for bodily injury or death, to the extent that all such damages are determined by a court of competent jurisdiction to have been directly caused by a defective Asanté product.

9. TO THE EXTENT ALLOWED BY LOCAL LAW, THE REMEDIES IN THIS WARRANTY STATEMENT ARE THE CUSTOMER'S SOLE AND EXCLUSIVE REMEDIES. EXCEPT AS INDICATED PREVIOUSLY, IN NO EVENT WILL ASANTÉ OR ITS SUPPLIERS BE LIABLE FOR LOSS OF DATA OR FOR DIRECT, SPECIAL, INCIDENTAL, CONSEQUENTIAL (INCLUDING LOST PROFIT OR DATA), OR OTHER DAMAGE, WHETHER BASED IN CONTRACT, OR OTHERWISE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages or imitations on how long an implied warranty lasts, so the previous limitations or exclusions may not apply to you. This warranty gives you specific legal rights, and you may have other rights, which vary from jurisdiction to jurisdiction.

Appendix D: Console Port Pin Outs

The console port is used to connect with a terminal using a serial modem RS-232C cable (available from Radio Shack's website, www.radioshack.com, catalog # 26-117). The setting is 9600-N81. The table below lists the pin outs.

Pin Number	Signal	Name
1	CD	Carrier Detect
2	RD	Receive Data
3	TD	Transmit Data
4	DTR	Data Terminal Ready
5	SG	Signal Ground
6	DSR	Data Set Ready
7	RTS	Request to Send
8	CD	Carrier Detect
9	RI	Ring Indicator

Appendix E. Online Warranty Registration

Please register the switch online at www.asante.com/support/warranty/index.html. By doing so, you'll be entitled to special offers, up-to-date information, and important product bulletins.

You may also register the switch by using the warranty card found in the printed Setup Guide.